JOURNAL

OF THE

AMERICAN FOUNDRYMEN'S

ASSOCIATION.

VOL. I. JULY, 1896. No. 1

The American Foundrymen's Association is not responsible for any statement or opinion that may be advanced by any contributor to this Journal.

PROCEEDINGS OF THE FIRST NATIONAL CONVENTION OF FOUNDRYMEN.

Pursuant to a call signed by a number of persons prominent in the foundry trade, a convention of the foundrymen of the United States was held in Philadelphia on Tuesday, Wednesday and Thursday, May 12, 13 and 14, 1896, with a very large attendance. The call was as follows:—

SECRETARY'S OFFICE,
PIER 45 NORTH DELEWARE AVENUE,
PHILADELPHIA, April 20, 1896.

I am requested to invite you, whether member of any foundrymen's organization or not, to attend the First National Convention of Foundrymen ever held in the United States, at Philadelphia, Tuesday, Wednesday and Thursday, May 12, 13 and 14, 1896. It is to be held under the auspices of the Foundrymen's Association, Philadelphia.

The object of this convention is to bring about a more friendly feeling among the foundrymen of this country, and to allow of the presentation and discussion of papers on interesting subjects,

aid to encourage the formation of Foundrymen's Associations in every part of the United States where it is possible to do so, believing in the end good results must follow.

In these days of severe competition and hard struggle for advancement, every foundryman should be alive to his best interests and feel it his duty to lend his assistance to advance the foundry business in every way. Every foundryman engaged in the operation of iron, steel or brass foundries, or identified with the same, as well as his wife and friends, will be welcome. Each visitor will be known as a delegate representing his firm or corporation.

HOWARD EVANS, Secretary.

COMMITTEE ON CALL.

The committee on the call for the convention was composed of the following, most of whom were officers and members of the Foundrymen's Association of Philadelphia:

Francis Schumann, President, Tacony Iron and Metal Co., Philadelphia.
Walter Wood, R. D. Wood & Co., Philadelphia.
S. G. Flagg, Jr., S. G. Flagg & Co., Philadelphia.
Thomas Glover, Glover Bros., Philadelphia.
E. E. Brown, E. E. Brown & Co., Philadelphia.
W. F. Sauter, G. Rebmann & Co., Philadelphia.
Thos. Devlin, Thos. Devlin & Co., Philadelphia.
John Birkinbine, M. E., Philadelphia.
W. H. Pfahler, Abram Cox Stove Co., Philadelphia.
W. H. Derbyshire, Bement, Miles & Co., Philadelphia.
J. Ogden Hoffman, Carnegie Steel Co., Philadelphia.
J. M. Warner, Rogers, Brown & Warner, Philadelphia.
J. Sellers Bancroft, Wm. Sellers & Co., Inc., Philadelphia.
Theo. B. Rohrman, Philadelphia.
Wm. Adams, Wm. Adams & Co., Philadelphia.
J. Thompson, J. Thompson & Co., Philadelphia.
H. C. Vansant, Morris, Tasker & Co., Inc., Philadelphia.
Asa Whitney, A. Whitney & Sons, Philadelphia.
Howard Sheppard, I. A. Sheppard & Co., Philadelphia.
D. J. Matlack, Wm. Cramp Ship and Engine Building Works, Philadelphia.
J. Harry Pepper, The Iron Age, Philadelphia.
Geo. Rominger, Girard Iron Works, Philadelphia.
Jas. Blankley, Blankley Bros. & Co., Philadelphia.
John Braun, J. Braun & Sons, Philadelphia.

J. S. Wilbraham, of Wilbraham-Baker Blower Co., Philadelphia.
W. W. Stevens, W. W. & R. S. Stevens, Philadelphia.
Thos. A. Daly, Iron Trade Review, Philadelphia.
Mr. A. W. Howe, Drexel Building, Philadelphia.
Frank R. Jones, Jerome Keely & Co., Philadelphia.
Charles James, M. E., Henry Disston & Sons, Incpd., Philadelphia.
Thos. Hobson, The Iron Age, Philadelphia.
W. T. Rainey, W. T. Rainey & Co., Philadelphia.
J. K. Bougher, J. W. Paxson & Co., Philadelphia.
F. A. Riehle, Riehle Bros. Testing Machine Co., Philadelphia.
Wm. J. Coane, Jos. Dixon Crucible Co., Philadelphia.
P. D. Wanner, Reading Foundry Co., Reading, Pa.
J. S. Stirling, Harlan & Hollingsworth Co., Wilmington, Del.
C. L. Prince, Camden Iron Works, Camden, N. J.
Geo. A. Messick, Pusey & Jones Co., Wilmington, Del.
E. D. Metcalf, D. M. Osborne & Co., Auburn, N. Y.
E. E. Durant, G. F. Warner Manufacturing Co., New Haven, Conn.
E. H. Jones, Vulcan Iron Works, Wilkes-Barre, Pa.
Robt. J. Regester, J. Regester & Sons, Baltimore, Md.
F. A. Flather, Lowell Machine Works, Lowell, Mass.
R. Bahmann, Blymer Iron Works Co., Cincinnati, O.
W. E. Fulton, Waterbury-Farrell Foundry and Machine Co., Waterbury, Conn.
Henry R. Worthington, Brooklyn, N. Y.
F. M. Davis, F. M. Davis Iron Works, Denver, Col.
W. H. Ridgway, Craig, Ridgway & Sons, Coatesville, Pa.
G. R. Elder, Supt., Ingersoll-Sergeant Drill Co., Easton, Pa.
F. N. Hoffstott, Clinton Iron and Steel Co., Pittsburg, Pa.
J. K. Dimmick, Anniston Pipe and Foundry Co., Anniston, Ala.
W. E. Sessions, Sessions Foundry Co., Bristol, Conn.
C. Kirchhoff, Editor The Iron Age, New York, N. Y.
Douglass G. Moore, S. L. Moore's Sons Co., Elizabethport, N. J.
John A. Penton, The Foundry, Detroit, Mich.
Geo. P. Smyser, E. G. Smyser's Sons, York, Pa.
Wm. A. Harris, Bausch & Harris Machine Tool Co., Holyoke, Mass.
A. I. Finley, Editor Iron Trade Review, Cleveland, O.

And the following officers and members of the Western Foundrymen's Association:

Jno. M. Sweeney, Chicago Consolidated Iron and Steel Co., Harvey, Ill.
A. W. McArthur, Rockford Foundry Co., Rockford, Ill.
O. T. Stantial, Illinois Malleable Iron Co., Chicago, Ill.
S. T. Johnston, Whiting Foundry Equipment Co., Chicago, Ill.
Geo. M. Sargeant, The Sargeant Co., Chicago, Ill.
W. N. Moore, Joliet Stove Works, Joliet, Ill.
James Frake, Chicago, Ill.

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A. Sorge, Jr., M. E., Chicago, Ill.
Thos. D. West, Sharpsville, Pa.
E. D. Hanna, Gates Iron Works, Chicago, Ill.
Wm. Ferguson, Gates Iron Works, Chicago, Ill.
J. H. Dalton, Walburn, Swenson & Co., Chicago, Ill.
B. M. Gardner, Iron Trade Review, Chicago, Ill.
John Pettigrew, Illinois Steel Co., Joliet, Ill.

CONTRIBUTORS TO CONVENTION FUND.

Preparations for the holding of the convention and the entertainment of the visitors were undertaken by the Foundrymen's Association of Philadelphia, and the expenses were met by a fund to which the following were contributors:

Henry Disston & Sons, Tacony, Philadelphia.
I. A. Sheppard & Co., Philadelphia.
Tacony Iron and Metal Co., Philadelphia.
R. D. Wood & Co., Philadelphia.
Thomas Devlin & Co., Philadelphia.
Girard Iron Works, Philadelphia.
J. W. Paxson & Co., Philadelphia.
Kavanagh & McDermott, Philadelphia.
S. G. Flagg & Co., Philadelphia.
Thomas D. West, Sharpsville, Pa.
Rogers, Brown & Warner, Philadelphia.
Pecora Paint Co., Philadelphia.
Jos. Dixon Crucible Co., Philadelphia.
Carnegie Steel Co., Philadelphia.
Blankley Bros. & Co., Philadelphia.
Morris, Tasker & Co., Ltd., Philadelphia.
Fuel Economizer Co., Matteawan, N. Y.
Harlan & Hollingsworth Co., Wilmington, Del.
Jerome Keely & Co., Philadelphia.
I. P. Morris Co., Philadelphia.
T. P. Kelly & Co., New York City.
G. Rebmann & Co., Philadelphia.
American Glutrose Co., Philadelphia.
Cyrus Borgner, Philadelphia.
Justice Cox, Jr., Philadelphia.
M. D. Valentine & Bro. Co., Woodbridge, N. J.
Ingersoll-Sergeant Drill Co., Easton, Pa.
The Wells Light Manufacturing Co., New York City.
Clinton Iron and Steel Co., Pittsburg, Pa.
Russell & Erwin Manufacturing Co., New Britain, Conn.
Ward & Nash, Boston, Mass.
Wilbraham-Baker Blower Co., Philadelphia.

Pennsylvania Iron Works Co., Philadelphia.
Morris, Wheeler & Co., Philadelphia.
B. W. Cotton & Co., Philadelphia.
L. & R. Wister & Co., Philadelphia.
W. P. Walter's Sons, Philadelphia.
Pulaski Iron Co., Philadelphia.
R. Hecksher & Son, Philadelphia.
A. W. Howe, Philadelphia.
C. R. Allen, Philadelphia.
Bement, Miles & Co., Philadelphia.
The Iron Age, Philadelphia.
The Pusey & Jones Co., Wilmington, Del.
Juniata Foundry Co., Philadelphia.
The S. Obermayer Co., Cincinnati, O.
Pedrick & Ayer Co., Philadelphia.
Washington Coal and Coke Co., Philadelphia.
Fanner Manufacturing Co., Cleveland, O.
Fred. Meerbach & Co., Frankford, Philadelphia.
J. Thompson & Co., Philadelphia.
Walter T. Bradley, Philadelphia.
Whitehead Bros. Co., New York.
E. E. Brown & Co., Philadelphia.
C. E. Williams & Co., Philadelphia.
Allentown Iron Co., Philadelphia.
Tamaqua Manufacturing Co., Tamaqua, Pa.
J. W. Hoffman & Co., Philadelphia.
Madeira, Hill & Co., Philadelphia.
Sloss Iron and Steel Co., Birmingham, Ala.
John Henning & Son.
Davis Coal and Coke Co.
J. J. Mohr, Philadelphia.
Eckert & Bro., Reading, Pa.
Reading Iron Co., Reading, Pa.
E. & G. Brooke Iron Co., Birdsboro, Pa
Syracuse Chilled Plow Co.
Abram Cox Stove Co., Philadelphia.
Crane Iron Works, Catasauqua, Pa.
Wm. Sellers & Co., Philadelphia.
Niles Tool Works, Hamilton, O.
Robert J. Taylor & Son, Philadelphia.
Tabor Manufacturing Co., Elizabeth, N. J.
Philadelphia Fire Brick Works.
Daniel Eagan, Chester, Pa.
American Steel Casting Co., Thurlow, Pa.
C. R. Baird & Co., Philadelphia.
Henry A. Hitner's Sons.
Whitney & Kammerer.
Thomas Iron Co., Easton, Pa.

LIST OF DELEGATES IN ATTENDANCE.

Asbury, Charles, Enterprise Manufacturing Co., Philadelphia.
Allison, Robert, Franklin Iron Works, Port Carbon, Pa.
Allen, Geo. R., Philadelphia.
Amsden, Alonzo D., Phoenix Foundry, Providence, R. I.
Adams, Wm., Wm. Adams & Co., Ninth st. and Girard ave., Philadelphia.
Arrote, Jas. W., Jr., Standard Manufacturing Co., Pittsburg, Pa.
Ackerman, Wm. W., Sam'l L. Moore & Sons, Elizabethport, N. J.
Adams, E. T., Juniata Furnace and Foundry Co., Marlborough and Beach sts., Philadelphia.
Anderson, James, Sotter Bros., Pottstown, Pa.
Bougher, J. K., J. W. Paxson & Co., Philadelphia.
Braun, John, Philadelphia Lawn Mower Co., Twenty-third and Turner sts., Philadelphia.
Blankley, James H., Blankley Bros. & Co., Twenty-second st. and Allegheny ave., Philadelphia.
Brown, Elmer E., E. E. Brown & Co., McKean and Meadow sts., Philadelphia.
Brown, John T., Damascus Bronze Co., Pittsburg, Pa.
Banholzer, Andrew, Birmingham Machine and Foundry Co., Birmingham, Ala.
Bishop, T. S., Russell & Erwin Manufacturing Co., New Britain, Conn.
Burgen, J. J., Lane Manufacturing Co., Montpelier, Vt.
Burr, John W., Burr & Houston Co., Brooklyn, N. Y.
Beckett, Jas. A., W. A. Wood Mowing and Reaping Co., Hoosick Falls, N. Y.
Buckley, Clinton S., Damascus Bronze Co., Pittsburg, Pa.
Best, Jos., Warden, King & Son, Montreal, Canada.
Brayer, Jno. F., Co-operative Foundry Co., Rochester, N. Y.
Bing, J. Howard, 3737 Filbert st., Philadelphia.
Brayer, Frank N., Co-operative Foundry Co., Rochester, N. Y.
Brooksbank, F. C., Ward & Nash, Boston, Mass.
Brown, Felix, Jr., A. & F. Brown, Elizabethport, N. J.
Berge, R. D., Clinton Iron and Steel Co., New York City, N. Y.
Bailey, James, Wilmington Malleable Iron Co., Wilmington, Del.
Barba, W. P., Midvale Steel Co., Nicetown, Philadelphia.
Baird, C. R., C. R. Baird & Co., Philadelphia.
Bell, C. S., The C. S. Bell Co., Hillsboro, O.
Buckwalter, J. A., The Buckwalter Stove Co., Royersford, Pa.
Blyth, Robert, Watertown, Mass.
Bradshaw, Jas. T., Twenty-first and Diamond sts., Philadelphia.
Booth, J. W., American Steel Casting Co., Thurlow, Pa.
Blackburn, A. H., Fuel Economizer Co., Matteawan, N. Y.
Barlow, A. E., Morris & Barlow, Newark, N. J.
Bailey, Charles, Reliance Steel Casting Co., Pittsburg, Pa.

Birkinbine, John, 25 N. E. Penn Square, Philadelphia.
Buckwalter, T. D., Buckwalter Stove Co., Royersford, Pa.
Bement, Wm. P., Bement, Miles & Co., Philadelphia.
Bate, Richard H., W. T. Bate & Son, Conshohocken, Pa.
Blickenderfer, R., Lancaster, Pa.
Bates, Hy. G., New York City, N. Y.
Brown, Albert D., Chester, Pa.
Brown, Archer, Rogers, Brown & Warner, New York.
Brown, Charles, A. & F. Brown, Elizabethport, N. J.
Borgner, Cyrus, Twenty-third and Vine sts., Philadelphia.
Betts, E. T., Betts Machine Co., Wilmington, Del.
Bougher, H. M., J. W. Paxson & Co., Philadelphia.
Coane, W. J., Jos. Dixon Crucible Co., 38 N. Fourth st., Philadelphia.
Caskey, Robert, Diller, Caskey & Co., Sixth and Berks sts., Philadelphia.
Cox, Mr., Cramp's Brass Foundry, Philadelphia.
Campbell, Twining, Paterson, N. J.
Cullingworth, J. R., Robert Wetherill & Co., Chester, Pa.
Coggeshell, T. R., Girard College, Philadelphia, Pa.
Cook, F. E., Westinghouse Air Brake Co., Pittsburg, Pa.
Choate, Chas. N., Bridgeport Deox, Bronze and Metal Co., Bridgeport, Conn.
Colvin, Theo. H., Providence, R. I.
Cox, Justice, Jr., 218 S. Fourth st., Philadelphia.
Carleton, A. C., Pratt & Whitney Co., Hartford, Conn.
Cheney, W. W., S. Cheney & Son, Manlius, N. Y.
Carpenter, Wm. H., A. Carpenter & Sons, Providence, R. I.
Coffin, W. H., Buffalo Foundry Supply Co., Buffalo, N. Y.
Carpenter, H. A., A. Carpenter & Sons, Providence, R. I.
Curtin A. G., L. and R. Wister & Co., Philadelphia.
Caldwell, A. J., Hy. R. Worthington, New York.
Cramp, Chas. D., Wm. Cramp & Sons, Philadelphia.
Cruickshank, W. Y., Jackson & Woodin Manufacturing Co., Berwick, Pa.
Codington, L. M., Standard Gas Fixture Co., Somerville, N. J.
Carr, Millard F., J. W. Paxson & Co., Philadelphia.
Derbyshire, Wm. H., Bement, Miles & Co., Twenty-first and Callowhill sts., Philadelphia.
Dette, Wm., Rogers, Brown & Warner, Bullitt Building, Philadelphia.
Darke, J. M., General Electric Co., Lynn, Mass.
Dalton, J. H., Walburn, Swenson & Co., Chicago, Ill.
Devlin, Walter, Philadelphia Hardware and Malleable Iron Co., Philadelphia.
Dimond, Harry C., Warder, Bushnell & Glessner, Springfield, O.
Donaldson, J. E., Ingersoll-Sergeant Drill Co., Easton, Pa.
Devlin, W. J., Philadelphia Hardware and Malleable Iron Works, Ninth and Jefferson sts., Philadelphia.
Davies, Geo. C., C. R. Baird & Co., Philadelphia.

Drinkhouse, Harry, Thos. Devlin & Co., American st. and Lehigh ave., Philadelphia.
Drummond, E. M., Drummond Manufacturing Co., Louisville, Ky.
Dimmick, J. K., Anniston Pipe and Foundry Co., Anniston, Ala.
Danleady, Geo., Ingersoll-Sergeant Drill Co., New York City.
Donoghue, M. O., Valentine Iron Co., Bellefonte, Pa.
Durant, E. E., G. F. Warner Manufacturing Co., New Haven, Conn.
Evans, Howard, J. W. Paxson & Co., Philadelphia.
Ellicott, C. N., C. N. Ellicott & Co., Philadelphia.
Edwards, E., General Electric Co., Lynn, Mass.
Ellicott, Geo. N., Southwark Foundry and Machine Co., Fifth st. and Washington ave., Philadelphia.
Echternach, W. H., Foundry of Girard College, Philadelphia.
Emerick, Geo. S., Geo. S. Emerick & Co., White Haven, Pa.
Eagan, Daniel, American Steel Casting Co., Thurlow, Pa.
Flagg, Stanley G., Jr., Stanley G. Flagg & Co., Nineteenth st. and Pennsylvania ave., Philadelphia.
Ferguson, Wm., Gates Iron Works, Chicago, Ill.
Frank, Isaac W., Frank, Kneeland Machine Co., Pittsburg, Pa.
Flagg, Geo., Stanley G. Flagg & Co., Philadelphia.
Fetz, John, Hanover Foundry and Machine Co., Hanover, Pa.
Farrell, Edw. P., Baltimore, Md.
Findley, A. I., The Iron Trade Review, Cleveland, O.
Floyd, H. E., James R. & Sons, New York.
Fulton, Wm. E., Waterbury-Farrell Foundry and Machine Co., Waterbury, Conn.
Freed, Y. C., Royersford Machine Co., Royersford, Pa.
Friend, J. W., Clinton Iron and Steel Co., Pittsburg, Pa.
Ferguson, J. H., Brownell & Co., Philadelphia.
Friend, J. T., Clinton Iron and Steel Co., Pittsburg, Pa.
French, Geo. W., J. J. Mohr, Philadelphia.
Goodrich, F. A., F. A. Goodrich & Co., Detroit, Mich.
Gibby, Geo. H., Condor Iron Foundry Co., Boston, Mass.
Groves, Samuel, Taylor, Wilson & Co., Limited, Pittsburg, Pa.
Gibby, F. W., Mechanics Foundry Co., Boston, Mass.
Gross, F. Max, Evening Star, Philadelphia.
Garrett, Hy. M., Westinghouse Machine Co., Pittsburg.
Gill, J. H., Raleigh, N. C.
Glover, Jno. H., Glover Bros., Frankford, Philadelphia.
Gisriel, Wm., Maryland Brass and Metal Works, Baltimore, Md.
Glover, Thomas, Glover Bros., Philadelphia.
Given, Saml. F., Bement, Miles & Co., Twenty-first and Callowhill sts., Philadelphia.
Greider, Ralph J., Paul S. Reeves & Son, Broad and Catherine sts., Philadelphia.
Graham, Geo. H., Oriskany Malleable Iron Co., Oriskany, N. Y.
Green, W. H., Jr., Vulcan Iron Works, Chester, Pa.

Gadd, H. W., of J. Wesley Pullman, Philadelphia.
Gilliams, Jno. F., United States Smelting Co., Philadelphia.
Howe, Arthur W., 430 Bourse Building, Philadelphia.
Hobson, Thos., The Iron Age, Philadelphia.
Harrison, Jno. W., Shickels, Harrison & Howard, St. Louis, Mo.
Howe, F. P., Wm. Wharton, Jr., & Co., Twenty-fifth st. and Washington ave., Philadelphia.
Holman, Thos. R., Holyoke Machine Co., Worcester, Mass.
Hill, John, S. Obermayer Co., Cincinnati, O.
Harkins, T. B., T. B. Harkins Foundry Co., Bristol, Pa.
Hanes, John, Woodstown, N. J.
Hodge, James M., Crane Iron Works, Catasauqua, Pa.
Hirsh, H. B., Midvale Foundry Co., Allentown, Pa.
Hayssen, Herman, Kohler, Hayssen & Stehn Manufacturing Co., Sheboygan, Wis.
Henderson, William C., Thos. Devlin & Co., Philadelphia.
Harris, Wm. A., Baush & Harris Machine Tool Co., Springfield, Mass.
Hartpence, S. C., Columbia Foundry Co., Philadelphia.
Hunsicker, H., Mount Penn Stove Works, Reading, Pa.
Hunt, W. H., Wm. Adams & Co., Philadelphia.
Hetherington, Geo., 222 Greenwich st., Philadelphia.
Hiesland, Benj. F., Marietta Casting Co., Marietta, Pa.
Hanson, Wm., Pennsylvania Iron Works Co., Fiftieth st. and Merion ave., Philadelphia.
Hubley, John C., Hubley Manufacturing Co., Lancaster, Pa.
Haeseler, C. H., Pedrick & Ayer Co., Tenth and Hamilton sts., Philadelphia.
Henry, T. M., North & Judd Manufacturing Co., New Britain, Conn.
Hammer, Alfred E., Malleable Iron Fittings Co., Branford, Conn.
Hammer, V. L., Malleable Iron Fittings Co., Branford, Conn.
Hibbs, Jos. S., J. W. Paxson & Co., Philadelphia.
Jones, Amos, Jones & Scullin, Philadelphia.
Jones, Frank R., Jerome, Keely & Co., Philadelphia.
James, Charles, Henry Disston & Sons, Tacony, Philadelphia.
Jarecki, Alexander, Jarecki Manufacturing Co., Erie, Pa.
Jones, Jesse, Wm. Cramp & Sons, Philadelphia.
Jobb, Chas. L., Londonderry Iron Co., Limited, Londonderry, N. S.
Johnson, Geo. T., Thomas Iron Co., Hokendauqua, Pa.
Jones, Thos., The Capitol Machine Tool Co., Auburn, N. Y.
Janney, Jos. A., Jr., Janney & Steinmetz, Philadelphia.
Julian, J. Henry, Gray's Ferry Foundry and Boiler Works, Philadelphia.
Kavanagh, Thos., Kavanagh & McDermott, Fifteenth st. and Lehigh ave., Philadelphia.
Knoppel, Jno. C., Buffalo Forge Co., Buffalo, N. Y.
Koons, A. F., Webster, Camp & Co., Akron, O.
Koons, Jos., L. V. R. R. Co., Weatherly, Pa.
Keep, W. J., Michigan Stove Co., Detroit, Mich.

Kelly, T. J., Moore, Kelly & Co., Philadelphia.
Kohler, J. M., Kohler, Hayssen & Stehn, Sheboygan, Wis.
Koken, Wm. T., Koken Iron Works, St. Louis, Mo.
Kirk, Dr. Edw., 535 N. Tenth st., Philadelphia.
Kuken, F. C., Geo. R. Allen, Thirteenth and Buttonwood sts., Philadelphia.
Kelly, R. B., T. B. Harkins Foundry Co., Bristol, Pa.
Kimball, W. G., S. G. Kimball's Sons, Newburgh, N. Y.
Kirchhoff, C., The Iron Age, New York City, N. Y.
Kelly, Jos. A., Scaife Foundry and Machine Co., Pittsburg, Pa.
Kelly, T. P., T. P. Kelly & Co., New York City, N. Y.
Keating, G. B., G. B. Keating & Co., Philadelphia.
Lindsey, Peter, Manayunk, Philadelphia.
Lindsey, Peter, Jr., Manayunk, Philadelphia.
Lambert, E. J., Syracuse Chilled Plow Co., Syracuse, N. Y.
Logan, Jno. A., Jones & Laughlin, Limited, Pittsburg, Pa.
Lincoln, Geo. H., G. H. Lincoln & Co., Boston, Mass.
Lanigan, James T., Davis Foundry Co., Lawrence, Mass.
Lacy, James J., James J. Lacy & Co., Baltimore, Md.
Loomis, Jacob, Elwood Iron Works, Elwood, Ind.
Lockhart, W. C., Scott Foundry, Reading, Pa.
Lane, H. M., Lane & Bodley Co., Cincinnati, O.
Laughlan, W. M., Pickands, Mather & Co., Cleveland, O.
Leonard, F. P., Dighton Furnace Co., Taunton, Mass.
Longstreet, J. H., Riverview Iron Works, Bordentown, N. J.
Lobdell, Wm. W., Lobdell Car Wheel Works, Wilmington, Del.
Lewis, T. S., Waterbury-Farrell Foundry and Machine Co., Waterbury, Conn.
Lane, E. J., R. D. Wood & Co., 400 Chestnut st., Philadelphia.
Matlack, George C., I. P. Morris Co., 1021 Richmond st., Philadelphia.
Matlack, D. J., I. P. Morris Co., 1021 Richmond st., Philadelphia.
McCormick, J. S., J. S. McCormick & Co., Pittsburg, Pa.
McLean, E., Pennsylvania, R. R., Altoona, Pa.
May, DeCoursey, Dixon Manufacturing Co., Scranton, Pa.
Moore, W. J. W., Crane Iron Works, Philadelphia.
Mosta, Geo., Leechburg Foundry and Machine Co., Pittsburg, Pa.
Magee, Frank A., Magee Furnace Co., Boston, Mass.
Mott, C. M., Abram Cox Stove Co., Lansdale, Pa.
Mosher, W. S., Mosher Foundry and Manufacturing Co., Dallas, Texas.
Messick, George L., Pusey & Jones Co., Wilmington, Del.
Messick, George A., Pusey & Jones Co., Wilmington, Del.
Mager, N., Jr., A. & P. Roberts & Co., Pencoyd, Pa.
McDermott, T. E., Kavanagh & McDermott, Philadelphia.
Michender, George R., Philadelphia.
McGrath, Louis J., Thomas Devlin & Co., American and Lehigh ave., Philadelphia.
Mosedale, F. C., Richards, Mather & Co., New Haven, Conn.

Moore, A. B., Samuel L. Moore & Sons Co., Elizabeth, N. J.
Morris, Henry G., Philadelphia.
Mills, John F., Abendroth Bros., Port Chester, N. Y.
Mott, Abram C., Abram Cox Stove Co., Philadelphia.
Miller, O., Westinghouse Air Brake Co., Pittsburg, Pa.
Mann, Earnest E., American Radiator Co., Detroit, Mich.
Murless, H. S., Rockville, Conn.
McCartney, H. J., American Telephone and Telegraph Co., New York.
Mohr, G. K., J. J. Mohr, Philadelphia.
Marshall, Alfred, Marshall Bros. & Co., Philadelphia.
Mumford, E. H., Elizabeth, N. J.
Moore, F. F., Monitor Iron Works, New York.
Morton, T. L., R. D. Wood & Co., Philadelphia.
Morris, F. M., Jeanesville Iron Works, Jeanesville, Pa.
Neave, John W., Pusey & Jones Co., Wilmington, Del.
Newkirk, I. Roberts, Wm. Wharton, Jr., & Co., Philadelphia.
Osgood, Edward P., Osgood & Hart, Charlestown, Mass.
Osborn, William, DuBois Iron Works, DuBois, Pa.
Outerbridge, A. E., Wm. Sellers & Co., Inc., Philadelphia.
Ormrod, George, Donaldson Iron Co., Emaus, Pa.
Ormrod, John D., Donaldson Iron Co., Emaus, Pa.
Paxson, John W., Jr., J. W. Paxson & Co., Philadelphia.
Prince, C. L., Camden Iron Works, Camden N. J.
Pepper, J. Harry, The Iron Age, 119 S. 4th st., Philadelphia.
Pfahler, W. H., Abram Cox Stove Co., Philadelphia.
Penton, John A., The Foundry, Detroit, Mich.
Payne, J. M., Rogers, Brown & Warner, Bullitt Building, Philadelphia.
Peckitt, Leonard, Crane Iron Works, Catasauqua, Pa.
Perault, M. J., Fitchburg, Mass.
Pickles, H. C., Wilmington Pipe and Foundry Co., Wilmington, Del.
Peterson, J. M., Valk & Murdoch, Charleston, S. C.
Pierce, E. B., Wheeler Foundry Co., Worcester, Mass.
Pole, Thos., Bement, Miles & Co., Philadelphia.
Pettinos, Geo. F., Pettinos Bros., Bethlehem, Pa.
Pettinos, C. E., Pettinos Bros., Bethlehem, Pa.
Patch, H. O., American Glutrose Works, Ninth and Chestnut sts., Philadelphia.
Pearse, W. C., American Glutrose Works, Ninth and Chestnut sts., Philadelphia.
Peacock, Wm., Union Lock and Hardware Co., Lancaster, Pa.
Potts, Henry, Pottstown, Pa.
Picard, A. J., Clinton Iron and Steel Co., Pittsburg, Pa.
Pedrick, H. A., Pedrick & Ayer Co., Philadelphia.
Rhoads, W. S., W. S. Rhoads & Co., Twenty-third and Wood sts., Philadelphia.
Rominger, Geo. G., Girard Iron Works, Twenty-second and Master sts., Philadelphia.

Rohland, John, Coxe Iron Manufacturing Co., Drifton, Pa.
Rankin, Thos. I., Abram Cox Stove Co., Philadelphia.
Ribert, J. M., Hubley Manufacturing Co., Lancaster, Pa.
Reed, Jno. C., Standard Manufacturing Co., Pittsburg, Pa.
Rorke, Jos. B., Philadelphia and Reading Iron Foundry, Reading, Pa.
Robinson, Edw., Wells Light Manufacturing Co., New York.
Rebmann, Godfrey, G. Rebmann & Co., Philadelphia.
Riehle, Fred. A., Riehle Bros., Ninth and Master sts., Philadelphia.
Rebmann, Harry G., G. Rebmann & Co., Philadelphia.
Ruhland, H., Girard Iron Works, Philadelphia.
Richards, Jos., Delaware Metal Refinery, Philadelphia.
Rea, H. R., Robinson & Rea Manufacturing Co., Pittsburg, Pa.
Robinson, W. O., Robinson & Rea Manufacturing Co., Pittsburg, Pa.
Russell, John R., Russell Wheel Foundry Co., Detroit, Mich.
Rood, V. H., Jeanesville Iron Works, Jeanesville, Pa.
Rebmann, G. R., Morse, Williams & Co., Philadelphia.
Rainey, W. T., W. T. Rainey & Co., Harrison Building, Philadelphia.
Rex, A. C., A. C. Rex & Co., Frankford, Philadelphia.
Search, Theo. C., President National Association of Manufacturers, Philadelphia.
Schumann, Francis, Tacony Iron and Metal Co., Tacony, Philadelphia.
Sheppard, Howard R., Isaac A. Sheppard & Co., Philadelphia.
Sauter, William F., G. Rebmann & Co., Philadelphia.
Stevens, W. W., W. W. & R. S. Stevens, Ninth st. and Montgomery ave., Philadelphia.
Stone, H. H., Pennsylvania R. R. Co., Altoona, Pa.
Sorge, A., Jr., Chicago, Ill.
Stein, Wm. H., Ticonderoga Machinery Co., Ticonderoga, N. Y.
Sutherland, A. G., Kansas City Wire & Iron Works, Kansas City, Mo.
Smyser, Geo. P., E. G. Smyser's Sons, York, Pa.
Smith, Jno., Jr., S. H. Hodge & Co., Detroit, Mich.
Shields, Curtis W., Ingersoll-Sergeant Drill Co., Easton, Pa.
Sadtler, J. P. B., Baltimore Link Sash Weight and Foundry Co., Baltimore, Md.
Shaw Bartlett M., Walker-Pratt Manufacturing Co., Boston, Mass.
Steward, James L., Armstrong Iron Works, Vineland, N. J.
Sleeth, S. D., Westinghouse Air Brake Co., Pittsburg, Pa.
Seaman, J. S., Seaman, Sleet & Black, Pittsburg, Pa.
Sawyer, J. C., Somersworth Machinery Co., Dover, N. H.
Speara, John, Columbia Grey Iron Co., Columbia, Pa.
Stibgen, Geo. F., Marietta Casting Co., Marietta, Pa.
Stirling, Jas. S., Harlan & Hollingsworth Co., Wilmington, Del.
Saunier, E. C., Clinton Iron and Steel Co., New York.
Smith, Pemberton, New York Car Wheel Works, Buffalo, N. Y.
Schaffer, F. B., Union Foundry Co., Elizabeth, N. J.
Scoville, E. U., Manlius, N. Y.
Scoville, Geo. B., Waterbury, Conn.

Sumner, Edw. A., American Radiator Co., Detroit, Mich.
Shuman, Frank, Tacony Iron & Metal Co., Tacony, Philadelphia.
Sherrard, J. M., Taylor Iron and Steel Co., High Bridge, N. J.
Smith, W. H., Whitehead Bros. Co., N. Y.
Stauffer, Howard, Columbia Grey Iron Co., Columbia, Pa.
Steinmetz, J. A., Janney & Steinmetz, Drexel Building, Philadelphia.
Smyser, Jas. A., E. G. Smyser's Sons, Baltimore, Md.
Smith, C. Ross, Madeira, Hill & Co., Philadelphia.
Shoen, Chas. P., Shoen Manufacturing Co., Pittsburg, Pa.
Smearman, M. F., Pennsylvania R. R. Co., Altoona, Pa.
Thompson, Josiah, J. Thompson & Co., Philadelphia.
Taylor, Robt., Taylor, Wilson & Co., Pittsburg, Pa.
Talbot, Benj., Pencoyd, Pa.
Treat, C. A., C. A. Treat Manufacturing Co., Hannibal, Mo.
Tittle, C. L., Blairsville, Pa.
Townsend, D., Philadelphia Roll and Machine Works, Philadelphia.
Taylor, R. J., R. J. Taylor & Son, Philadelphia.
Taylor, H. B., Pettinos Bros., Philadelphia.
Tolmie, Robt. C., Lobdell Car Wheel Co., Wilmington, Del.
Tyler, Walter B., Southern Foundry and Machine Works, Fredericksburg, Va.
Taylor, Clarence, Philadelphia.
Valentine, H. R., M. D. Valentine & Bro. Co., Woodbridge, N. J.
Van Tine, G. W., Singer Manufacturing Co., Elizabeth, N. J.
Voight, Chas. F., Sterling Metal Ref. Co., Philadelphia.
Warwick, Chas. F., Mayor of Philadelphia.
Wood, Walter, R. D. Wood & Co., Philadelphia.
Wilbraham, John S., Wilbraham Baker Blower Co., Philadelphia.
Warner, John M., Rogers, Brown & Warner, Philadelphia.
Whitney, Asa W., A. Whitney & Sons, Philadelphia.
Winchester, I. W., Magee Furnace Co., Chelsea, Mass.
Wathey, Thomas, United Verde Copper Co., Jerome, Arizona.
West, Thos. D., Sharpsville, Pa.
Wiard, Geo., Wiard Plow Co., Batavia, N. Y.
Wittingham, A. J., Moore, Kelly & Co., Philadelphia.
Winlock, J. P., Barbour, Stockwell & Co., Cambridge, Mass.
Walker, Arthur W., Walker & Pratt Manufacturing Co., Boston, Mass.
Weyhenmeyer, Jerome, Jeanesville Iron Works, Jeanesville, Pa.
Weaver, E. E., Midvale Foundry Co., Allentown, Pa.
Wheeler, Andrew, Morris, Wheeler & Co., Philadelphia.
Whitehead, V. L., Whitehead Bros. Co., Buffalo, N. Y.
Whiting, C. W., Van Bergen & Co., Limited, Carbondale, Pa.
Webster, Wm. R., Philadelphia.
Whittemore, Harris, Naugatuck Malleable Iron Co., Naugatuck, Conn.
Walder, Amos, Genesee Foundry, Rochester, N. Y.
Walker, Geo. R., J. Thompson & Co., Philadelphia.
Wortham, R. M., Keystone Brass Foundry, Philadelphia.

Williams, Thos. H., A. A. Griffing Iron Works, Jersey City, N. J.
Walker, W. W., Pusey & Jones Co., Wilmington, Del.
Wood, C. R., R. D. Wood & Co., Philadelphia.
Wilson, A. D., Greys Ferry Foundry and Boiler Works, Philadelphia.
Yagle, Wm., Wm. Yagle & Co., Limited, Pittsburg, Pa.
Young, M. B., Philadelphia.

ENTERTAINMENT COMMITTEE.

The entertainment of the visitors devolved upon a committee composed of the following:

Walter Wood, Chairman, R. D. Wood & Co., Philadelphia.
S. G. Flagg, Jr., S. G. Flagg & Co., Philadelphia.
Thomas Glover, Glover Bros., Philadelphia.
E. E. Brown, E. E. Brown & Co., Philadelphia
W. F. Sauter, G. Rebmann & Co., Philadelphia.
Thos. Devlin, Thos. Devlin & Co., Philadelphia.
John Birkinbine, M. E., Philadelphia.
W. H. Pfahler, Abram Cox Stove Co., Philadelphia.
W. H. Derbyshire, Bement, Miles & Co., Philadelphia.
J. Ogden Hoffman, Carnegie Steel Co., Philadelphia.
J. M. Warner, Rogers, Brown & Warner, Philadelphia.
J. Sellers Bancroft, Wm. Sellers & Co., Inc., Philadelphia.
Theo. B. Rohrman, Philadelphia.
Wm. Adams, Wm. Adams & Co., Philadelphia.
H. C. Vansant, Morris, Tasker & Co., Inc., Philadelphia.
Asa Whitney, A. Whitney & Sons, Philadelphia.
Howard Sheppard, I. A. Sheppard & Co., Philadelphia.
D. J. Matlack, Wm. Cramp & Sons Ship Building and Engine Co., Philadelphia.
J. Harry Pepper, The Iron Age, Philadelphia.
Geo. Rominger, Girard Iron Works, Philadelphia.
Jas. Blankley, Blankley Bros. & Co., Philadelphia.
John Braun, J. Braun & Sons, Philadelphia.
W. W. Stevens, W. W. & R. S. Stevens, Philadelphia.
Mr. A. M. Howe, Drexel Building, Philadelphia.
Charles James, M. E., Henry Disston & Sons, Philadelphia.
W. T. Rainey, W. T. Rainey & Co., Philadelphia.
Charles T. Holbrook, Juniata Furnace and Foundry Co., Philadelphia.
F. A. Riehle, Riehle Bros. Testing Machine Co., Philadelphia.
F. C. Davis, Davis Coal and Coke Co., Philadelphia.
Geo. A. Messick, Pusey & Jones Co., Wilmington, Del.
John A. Penton, The Foundry, Detroit, Mich.
A. Sorge, Jr., & Co., Chicago, Ill.

The visitors arriving on Monday evening and on Tuesday reported at the convention headquarters, located at the Manu-

facturers' Club, and after registering were furnished with badges consisting of a metal button with a ribbon of blue and gold, the official colors of the city of Philadelphia. Each ribbon bore the register number of the wearer, in order to facilitate identification during the convention, a printed list being furnished each delegate daily, giving list of those in attendance, their business affiliations, etc., each name being prefixed by the number on badge, thus rendering identification easy. The attendance register was in charge of Sergeant-at-Arms C. T. Holbrook.

The lady visitors were consigned to the care of a committee of ladies comprising the following:

Mrs. C. L. Prince, Chairman,	Mrs. G. S. Rominger,
Mrs. C. E. Gruger,	Miss G. F. Thompson,
Mrs. Wm. Trinkle,	Miss G. T. Thompson,
Mrs. J. Thompson,	Miss H. J. Thompson,
Mrs. J. S. Wilbraham,	Mrs. W. H. Derbyshire.

The committee ably discharged their duties and spared no effort to make their visitors' stay in the city one of enjoyment.

FIRST SESSION.

MANUFACTURERS' CLUB,
PHILADELPHIA, PA., Tuesday, May 12th (2 P. M.)

The meeting was called to order by Francis Schumann, President of the Philadelphia Foundrymen's Association, who addressed the meeting as follows:

Gentlemen:—To me falls the honor on behalf of the foundrymen of Philadelphia, of greeting you and bidding you welcome. We will endeavor to make your visit one both of pleasure and usefulness.

We have undertaken to bring together here those interested in the welfare of an industry consisting of nearly 4,000 separate establishments, with an aggregate capital invested of about $115,000,000, employing about 120,000 persons, whose annual wages amount to nearly $63,000,000. Some 2,600,000 tons of castings are produced annually, requiring some 43,000 tons of coal and coke. The total annual disbursements for material and labor amount to $114,000,000.

This is the first time in the history of our country that those engaged in so great an industry have ever met to confer upon questions relating to their mutual welfare.

The excessive, and to a certain extent artificial, competition now existing in all industries of this country has brought about a general movement tending toward combinations, for the purpose of combating and controlling this unrestrained and dangerous rivalry.

Prices have taken a downward course, far below that which healthy competition would warrant. It has not only resulted in greatly deteriorating the character of the product and undermining that finer sense of honor of the individuals engaged, but is also testing to its utmost the endurance of strong establishments whose very existence is at stake, no matter how well prepared they may have been at the beginning of the struggle. We are living in an era of conflict; on the one hand, organized and concentrated capital; on the other, that which is scattered and disunited. Weak or partial organization will not avail. Unless all engaged in an industry will unite and adopt vigorous measures that may be rigidly enforced for controlling the individual members, the result will be failure.

Our establishments are the result of our life's labor; we intended and hoped that they should endure beyond our time. To maintain these intentions and hopes has brought about this convention of foundrymen from all parts of this great country.

You are here to deliberate upon questions of great importance to all, primarily that of organization. Let us be wise and above all personal matters that conflict with the aims and objects of this convention, the prosperity of the foundry industry. We have with us one whom the citizens of Philadelphia highly esteem, Hon. Charles F. Warwick, the Mayor of our city.

Mr. Schumann then introduced Mr. Warwick, who said:

Mr. Chairman and Gentlemen:—We have prepared, as you see, a warm reception for you (laughter), and I am here to give you a warmer one, because our hearts, as well as the sun, have united to make it as pleasant for you as possible. I am now one

of your number, as I have this badge, which has been given to me by the gentleman who originally invited me to come here and extend to you a welcome. He told me that it is No. 238, and he whispered in my ear that this will admit me to any place within the city of Philadelphia. (Laughter.) In order to make this badge complete there should be another, and I will furnish that at the City Hall, to let you out. (Laughter.) There is only one thing that makes me fear this badge, and that is the number on it, and I want the pledge of every man here that there is not another No. 238. (Laughter.) Mr. Evans has given me his, and I know him well, and I don't want to be responsible for all that he may do. (Laughter.) I do extend to you, gentlemen, the welcome of the city of Philadelphia. Philadelphia is becoming a city of conventions. St. Louis and Chicago, in the past, have been the great cities of conventions, but they have so many jobs on hand just now that I suppose you have decided to come to Philadelphia for the purpose of holding the first convention of this character in the United States. As this is your initial performance, it is essential that you should make it a success, and we feel glad that you have seen fit to take advantage of the facilities afforded by our city to hold this your first meeting. Time was when conventions of this magnitude were not often held; when the roads were steep; when travel was inconvenient; when the highwayman abounded upon every course where travel set its way. But we live in an age of civilization; we live in an age of progress; and the two great civilizers in the history of the world are steam and electricity. Steam and electricity give us the opportunity of holding these conventions, which bring us closer together. Steam and electricity draw the whole world to our feet. It is nothing now to take a trip across the waters, or to travel from one of the republics to the other. Once it was a dread; to-day it is a pleasure. We have here in this assembly, I am told, men who come from every quarter of the republic—from Idaho, Montana, and from far out on the Pacific slope; we have men from the New England States; men from the Southern States; representatives from Atlanta—and Atlanta is especially near to the heart of Philadelphia; Atlanta gave to our city a

reception when she sent the old bell there that has perhaps never been equalled in the history of the world. Patriotism and loyalty and devotion were shown by the people of Atlanta when the old bell reached that city of the South that was unexcelled; and I have seen many receptions, I have been at many meetings, public meetings of every character, and I don't think I have ever in my life seen anything so kindly received as was that old bell in the city of Atlanta. And I am glad that Atlanta and that Georgia are represented in this assembly to-day. Now pardon me when I say that this is a good city that you have come to. It is a city of a million and a quarter of population; it is a city that has the smallest debt, proportionately; it is a city that has made the greatest progress within the past two years—according to statistics—than any city of like advantage, and like size, and like opportunities, on this continent. And you are here in this city where you ought to hold your first meeting of foundrymen, because it was here that the Constitution of our nation was cast; it was here that assembled in Independence Hall the founders who held their initial meeting in old Independence Hall, that established, and founded, and cast this form of government of ours which leads the world, and I predict that, in the providence of God, has a future before it far beyond our ken and prophecy. (Applause.) They were great foundrymen, those old fathers of ours, for in those days when they were founding this republic, in those days when they were drafting the Declaration of Independence, in those days when they were creating the Constitution—that came out of friction, that came out of fire, that came out of anguish, that came out of sorrow, that was born of a holy desire for freedom—those men met in that great foundry of Independence Hall, and as the founders of this great nation, that was destined to be—with all this hope, with all this great future before them—little did they know, little did they appreciate, the work that was being formed and founded by their hands and minds. They could not look out into the future with prophetic vision; they could not have seen this nation, great as it has grown, embracing three thousand miles of land from ocean to ocean, and from the lakes on the north to the gulfs on the south, all cemented

together with wires that flash the news along and transport humanity from place to place; they could not have looked out in their wildest schemes or in their wildest imagination, into the future and seen what we see about us to-day. It is the greatest effort of the human race, the establishment of this government of ours—the saving of this great republic; and the great future of this republic is safe because of the application of steam and electricity that bring us so close together that we do away with our prejudices and our narrowness. It makes us to know our friends from every quarter. Whether they come from Texas or from Idaho, they are in touch with us; and there is nothing that exemplifies this so well as the great foundry industry that has millions of money invested in capital, hundreds of thousands of employees, and above that, the disbursement of millions of dollars in wages. There is no country under the face of the heavens that can compare with this. Though you come from all sections of the country and meet in this city of "Brotherly Love," yet you meet here speaking the same tongue, the English tongue—our mother tongue—our cradle tongue; you speak in a language that I know, that we all know, and that language cements and binds us together, and makes a people that will never grow old; a common, every-day, practical people who drive the vehicle of trade along and make prosperity for the nation. In this country, governed in this way, set apart by the providence of God, we meet here representing this industry; we come and speak together, and speak the same mother tongue; your language is mine, and mine is yours, and that unites us to the brotherhood that I believe is to be ultimately the safety of this nation. From every quarter of the country you have come, all listening to me, all thinking with me, and all drawing your conclusions from what I say in a tongue that is just as much yours, though you come from Idaho, or New Mexico, as it is mine, born in this city of Philadelphia. With steam, with electricity, with one tongue, and with the education of the people and the influence of the best thought emanating from university life and university training, this country is safe for all time; and there is nothing that will make it safer than bringing these national conventions together where we may find

that our interests have a common purpose. I am glad to meet you. I have run from a busy desk in order that I might bring to you a welcome. I am glad to give you all the welcome that the city can grant, I want you to take care of your badges; that is the only thing that will identify you. (Laughter.) I am inspired by your purpose, from the fact that this is the first meeting that has ever been held of this kind in this city. The city extends all the courtesy it is possible to give. I welcome you warmly and sincerely. I wish you success, and that your deliberations may increase your resolutions in other directions that shall have an influence upon the well-being of the country at large; and this is the concluding wish of him whose pleasure it is to welcome you in our midst. (Applause.)

On motion, three cheers were tendered the Mayor, when he retired.

Mr. Howard Evans, of Philadelphia, announced that after 6 p. m. there would be free telegraph service for members of the convention to any point throughout the United States, by courtesy of the Western Union Telegraph Co. "The official button," said Mr. Evans, "will be the 'open sesame,' and a special instrument placed in this Club will be at the service of the members."

Mr. Schumann—This meeting is highly favored to have the presence among us of a gentleman who has assumed the herculean duties of organizing the manufacturing industries of the United States—Theodore C. Search.

Mr. Schumann then introduced Mr. Search, who made the following address:

Gentlemen—A few days ago I was very much astonished at receiving a note from your Secretary, asking me if I would not come up and entertain you a few minutes to-day. At first thought I should have declined, but when I considered that I represented an organization which probably was interesting to you, and which should be identified with you, and you with it, I could hesitate no longer; so I wrote him a letter, saying that I would come. My first thought was that it would be very easy to come here and

make an address which should be full of good will and good feeling for you, and make you feel that we had an interest in you; but I happened to put my hand in my pocket and pulled out a programme for the occasion, and as I looked down the column I saw that you were going to consider here mighty matters, and I thought I would be recreant to the trust imposed upon me should I come here and flippantly toss the matter to one side, and so this forced me to put on my thinking cap, and I have prepared what I have to say and put it upon paper that I might give it to you with some logical sequence.

A glance at the subjects for discussion at this meeting indicates that your society means to be progressive and not unmindful that the close of the present century demands intelligent answers to questions that had no existence at the beginning, were but crude imaginings fifty years ago, not well known twenty-five years later, but which now press upon you from all sides demanding investigation and solution. In the history of man there does not appear to have been a time so potent as the present for calling into being all the latent energies and powers of the human race. The great past has accumulated such a vast storehouse of facts that it somehow is incumbent upon the present to generalize these accumulations and construct laws that shall harmonize and unify and make subservient to our uses all these treasures. The more we can pass these details into review before us, the more complete will be our mastery over the science that underlies our work and controls with startling power our further advances into the region of investigation and accomplishment.

Each new year, therefore, brings its contribution before us and demands our best and highest consideration. No matter how thoroughly you may dispose of the pressing questions of the day, the human mind is so constituted that every science problem we may solve is but a key to unlock the door of still deeper mysteries which shall test the keenest training of mind and body. It is the solution of these ever-recurring problems that makes progress; that sets a still higher niche in the wall; that submerges the high-water mark of yesterday; that notifies us that to-morrow will

introduce problems which only those who meet and solve those of to-day can hope to successfully encounter.

The properly trained man in every profession to-day is a live man, a thinking man, an orderly man and a methodical man. He grasps ideas as they float through the brain, he consolidates these mental actions with precision and forces them into being with all the energy and power of his will. He makes things come to pass. He designs, he executes, he succeeds. In short, activity is the very essence of his being; but it is the activity of habit, it is the outgrowth of years of study, it is the result of long hours of preparation, it is his observation of nature in all her different moods, and his constant endeavor to understand the natural causes which produce effects that make a powerful engine for driving the forces of nature into such lines of energy as may seem best fitted to harmonize and develop his career.

In all this turmoil the survival of the fittest to handle these natural forces is self-evident, and, therefore, it is with no little satisfaction that we to-day witness this meeting of the foundrymen of the United States in the city which, since the days of Rittenhouse and Franklin, has been the home of a deep and abiding faith that scientific thought of the very highest quality belongs by right to all industries, and that it is the wisest use of our energies to bring them to bear on the practical and possible elements of investigation.

Perhaps the most important thought I can present to you is my abiding faith in our own country and the relative value of its working energy. Mulhall, in his recently published tables, gives some statistics of the productive energy of various countries, and he shows that the aggregate of all the energies in use in the United States in 1820 was equal to 446 foot tons per capita. In 1890 this had increased to 1,940 foot tons, and the position of the other countries was as follows:

England	1,470
Germany	902
France	910
Spain	590
Austria	560
Italy	380

To present this comparison in a form more readily comprehended, let me reduce it to percentages, taking the productive capacity of the United States as 100. Then we will have:

England	70
Germany	46½
France	47
Spain	30
Austria	29
Italy	20

From this it will be seen that we produce per capita 1 3-7 times as much as England, 2 1-10 times as much as Germany or France, 3 1-3 times as much as Spain or Austria, and 5 times as much as Italy. These figures have a deeper significance than a superficial glance would show, as they indicate that our own country is a productive factor that cannot be much longer confined to its own limits for trade; that the higher wage of our labor is being rapidly discounted by the effectiveness of our methods, and that the markets of the world are not so far from our grasp as the workingmen may imagine.

We are rapidly demonstrating that it is possible to overcome the higher wage earnings of our labor by a greater product, and that it pays to maintain the splendid efficiency of our workmen for the sake of its greater value. That it has been possible to maintain the wages of our labor in the face of continually declining prices of nearly all products, has been due to the constantly increasing productive capacity of our workmen and machinery. The substitution of science for the "rule of thumb" has also contributed to the same results. In your own industry improved cupola construction has lessened the consumption of fuel in melting iron, molding machines have largely increased the output per man on certain lines of work, while improved appliances for handling material, molds and castings have materially lessened the cost of labor by increasing the efficiency of each unit.

In the manufacture of iron and steel there has been a wonderful increase in the productive capacity of labor through the introduction of better methods and more efficient machinery. The production of pig iron in the census year 1870 averaged about 53 gross

tons for each man employed in the industry; in 1880 it was about 81 tons and in 1890 it was about 321 tons. In 1876 the average annual capacity of each blast furnace was only 6,811 gross tons, while at present the average is 37,065 gross tons, so that while the total number of blast furnaces has decreased from 713 in 1876 to 469 at present, their aggregate annual productive capacity has increased during the same time from 4,574,312 gross tons to 17,373,637 tons. In the last four years the number of Bessemer converters has increased only from 95 to 99, yet the productive capacity has grown from 5,857,143 gross tons in 1892 to 9,472,550 tons at the beginning of this year.

In 1884 the average daily output of coal for each man employed in the bituminous mines of Pennsylvania was 2.13 tons, while in 1894 it was 3.22 tons, and during the same ten years the output of anthracite increased from 1.70 tons per man per day to 2.07 tons.

The evolution of our textile industries has been marked by a marvelous increase in the productive capacity of labor, of which I have time to give but a few illustrations. The introduction of the Brussels power loom in 1848 by Erastus B. Bigelow, increased at a single stride the productive capacity of a single weaver from three or four yards of carpet daily to twenty or twenty-five yards. Forty years ago our woolen manufacturers used a broad loom which ran about 40 picks per minute; now they run up to 100 picks and more.

In the manufacture of cotton goods there have been wonderful improvements in all the processes of carding, spinning and weaving. In 1870 the best type of frame spindle which was available to our cotton manufacturers was capable of 5,500 revolutions per minute, while in 1890 the possible speed had increased to 10,000 revolutions, and since that time there have been still further developments in this line. From the hand loom to the power loom was a great step in itself, but instead of the machine which formerly required the undivided attention of an operative, we now have looms which are so largely automatic in their operations that a single weaver can tend eight of them.

I might go on thus from industry to industry, showing how invention has supplemented the manual skill of our laborers and

enormously increased their productive power, but what I have said will suffice for purposes of illustration and to demonstrate why our labor though highly paid is not dear.

Let me pass now to another thought which is particularly pertinent to this occasion. This is essentially an era of organization, and I view the multiplicity of trade and technical associations as an evidence of the recognition of the need for concerted action in striving to attain desired objects. There are distinct fields of usefulness for all these various organizations, and I feel assured that you who have participated in the discussions of the Foundrymen's Association of Philadelphia, the Western Foundrymen's Association or any of the kindred organizations, can furnish ample evidence of the benefit which you have derived from such interchange of thought and exchange of ideas. The man who does not keep closely in touch with his competitors in these days is likely to find himself far behind in the race. No man has a monopoly of the good ideas in any branch of industry, and there is no man who is so well informed, so thoroughly conversant with the details of his own business, that he can learn nothing by discussion with his fellow manufacturers. Those who know the most, those who are the most progressive in their business, are the most willing to acquire new ideas which will place them still further in the lead.

The purposes of this convention—to bring the foundrymen of the country together in a national assemblage and to encourage the formation of local organizations—are indicative of the needs of the day, not only in this particular branch of industry, but in all lines of business. Local associations with concentrated memberships are able to discuss in frequent meetings such topics as are local in their importance or of technical interest. For a national association, representing the constituencies of all the local organizations, there is also a distinct field of usefulness in the consideration of broader problems which bear upon the industry at large without regard to locality. There need be no conflict between local and national associations, for each is useful to the other. Along certain lines a national body can exert more powerful in-

fluence than is possible to any local organization, while in other matters a local organization can do all that is needful.

We have national organizations of manufacturers of boilers, glass, wagons, agricultural implements, iron and steel, carriages, furniture, stoves, woolen goods, bicycles, bricks, cigars, confectionery, lumber, paints and varnish, and many other articles. Each of these organizations voices the sentiments and exerts the influence of an important and powerful constituency. As representing the interests of great industries the importance of these national associations cannot be questioned.

But there are needs which even these organizations do not fully meet. There are problems which have an equal interest for all lines of business and for all branches of manufactures, and their successful solution demands the united action of all the interests which are involved. It was this condition of affairs which gave birth to the National Association of Manufacturers, which aims to unite all manufacturers in their efforts to secure those results which are of equal importance to all of them. It is not the aim of this association to supplant any of the other national or local organizations nor to interfere with their work in any manner. On the contrary, it is our purpose to supplement their efforts and to extend their influence, and to unite in one powerful movement all the forces now separately and independently exerted. The possibilities of such a concentration of power are tremendous. When the manufacturers of the United States shall lend their united energies to the accomplishment of any desired result there is no obstacle which can bar their progress. in the belief that every attempt at organization, either local, state or national, is a recognition of this possibility, I view with great pleasure this present gathering of foundrymen from every section of our country, and I wish you all possible success in the work of this convention.

Mr. Schumann:—Gentlemen, these expressions by Mr. Search in his address will greatly aid us in gaining our object—organization. Mr. W. H. Pfahler will now address you as to the immediate objects of this convention.

Mr. Pfahler:—Mr. Schumann has just intimated that I am to tell you something about this organization. I found out, a few moments ago, that I was to take the place of Mr. John Birkinbine. Now if you know Mr. Birkinbine you will know what a poor substitute has been selected. Mr. Search has very pointedly covered all the ground there is to cover on the question of organization; it does not seem to me to be a question that need be further considered. When I look over this meeting, when I see men here who are as busy as I am—men, perhaps, who have more to do than I have, who have taken the time from their business, who have traveled, perhaps, thousands of miles and come here upon the invitation of the Philadelphia Association of Founders, I feel that we have assumed a very grave responsibility unless we give you all something to do, or the opportunity to do something, and that is what this meeting has been called for. We have called you together because we believe that there is something that can be done to further your interests, to further the interests of every individual by co-operation, by organization. His Honor, the Mayor, has very pointedly said that this country is one that is so large that it must act in harmony. I think that the men from Idaho, or from South Carolina, or from Texas, have something in common, and should always be ready to come together when the opportunity is offered. He has told you of the advances made by reason of the opportunities that have been given us to increase commerce by the operation of the telegraph, by the wire, by the rail, and as he spoke I thought how little the Mayor knew that right here in this industry was represented more plants than any other industry in the country to-day. There is no appliance in the line of progress that has not been made by the plants that have been represented here to-day. But I am not here to talk on this line; I only want to say this as a bit of history, that three or four years ago a half dozen of the foundrymen of Philadelphia happened to meet incidentally, and they talked of the advantages of an association that would bring together all the foundrymen of Philadelphia. They expressed their ideas, and I think the success attained has been due to the fact that they had no purposed organization, and the work will go on, and you can-

not stop it. They soon found that they had something in common; they soon found that no one could speak but what he said something that perhaps another man did not know, and it was soon ascertained that we were more willing to impart that which we had than we thought we were; we got more for what we said than what we had given. Gradually this association grew into a membership of thirty or forty, and right here in the city of Philadelphia, men engaged in the same business, men whose names were known all over the city, met in this room and were introduced to each other, and the most interesting part of it was to see how rapidly they discovered that each one of them didn't have the horns or the tail that they imagined he had. (Laughter.) That they were men of common purposes; that they were men who knew how to work, and only failed to reap the good results of their work when they came into competition with each other on lines that were unprofitable. With common business sense they went back to their offices feeling sure that half of the stories they heard about their competitors were without foundation. The association grew until we have now a membership of 150, scattered not only through Philadelphia, but throughout five or six adjoining cities, and at the meetings held every month, we have 50, 60 or 75 members. And what for? Simply to come in contact with men who are willing to learn and to teach. Some one conceived the idea that it would be well to bring the foundrymen together from all over the country. The idea seemed to be well favored; it grew, and out of it has come this meeting. There is no purpose in calling you together but to give you a chance to say what you feel and what you believe. What we want is the expression of every man in this room as to how best to further the movement. I feel that we have never seen a meeting of any association which represented so large and important an industry as this meeting to-day. The only thought that I can offer, or that I want to offer, is that each man in the room will feel that he is here not only to listen to the programme that has been brought out, but that he is here to say what he believes may be of good to the foundrymen of the country. I hope it will lead to such an association in this country as shall grow not only in numbers—as it must grow—but in

importance, in value; and it must grow in the results that the country will be benefited from the work that you will do. (Applause.)

At the close of Mr. Pfahler's remarks Mr. Schumann called for nominations for a temporary chairman and secretary before proceeding with the business of the convention.

Mr. Schumann and Mr. Evans having been unanimously selected, the following was offered by Mr. F. A. Riehle.

Whereas, There are now in existence in different portions of America various associations of foundrymen doing their work in restricted territories; and

Whereas, The work done by these associations has been productive of much benefit to our foundry interests; and

Whereas, There are many foundrymen not now, and under present conditions not likely to be, affiliated with any of these associations; and

Whereas, It is desirable that the interests of the foundry business should be furthered by a closer association among all the foundrymen of America in order that any improvements or valuable information concerning the business, or any portion of it, should become as widely available as possible; therefore, be it

Resolved, That it is the sense of this convention that there shall be formed an American Foundrymen's Association to further the closer relationship among foundrymen necessary to carry out the objects set forth in the preamble to this resolution; and let it be further

Resolved, That a committee of five be appointed by the Chair to draw up the necessary Constitution and By-Laws for the proper government of the said American Foundrymen's Association, and to report to this body at the earliest possible moment.

The resolutions having been adopted, the Chair, upon motion being made to that effect, appointed the following committees:

Committee on Constitution—A. Sorge, Jr., Chicago, Ill.; William Taylor, Pittsburg, Pa.; Frank A. Magee, Boston, Mass.; C. S. Bell, Hillsboro, O.; J. Best, Montreal, Can.

Committee on Nominations—Mr. Stanley G. Flagg, Philadelphia; Mr. H. M. Lane, Cincinnati, O.; Mr. S. Groves, Pittsburg; Mr. J. A. Beckett, Hoosick Falls, N. Y.; Mr. William Ferguson, Chicago.

Mr. James Blankley moved that a recess be taken in order to allow the committees to confer.

The Chairman:—It seems to me that the reports of the committees should be deferred to the closing session of the convention. In the meantime, if it is the desire of the gentlemen to discuss the resolutions just adopted, a motion to reconsider will be in order.

The point having been made that the resolutions just adopted were not generally understood, S. G. Flagg, Jr., moved that they be reconsidered in order that they might be more fully understood and the importance of the move under contemplation better appreciated. The motion having been duly seconded was carried.

Mr. Walter A. Wood:—Perhaps if we reconsider these resolutions it might lead to confusion. If any desire to discuss them would it not be better to let the discussion take the form of instructions by the meeting to the committee?

The Chairman:—It will be well for all those who have any thoughts on the subject to give them free expression, and let us have the discussion as full as we can possibly have it, to see whether it is our desire to form the association. I don't think we should be particular to stick to strict parliamentary usage, but what we desire is free expression of opinion. I would like to hear from Chicago—Mr. Sorge is a member of the Western Association, although he is here as an individual, not representing his association.

Mr. A. Sorge, Jr.:—As far as the question of a national organization, of the character outlined in the resolution is concerned, I think that such an organization can serve a most excellent purpose in a number of directions. I think that primarily the objects expressed in the resolution—or in the preamble to the resolutions—show the direction in which such an organization should work. It should work for the purpose of gathering within its fold not

only the present existing organizations, but should endeavor to gather within it all the members outside of such organizations, and in localities where local organizations cannot be formed. It should further endeavor to work for disseminating among foundrymen in various parts of the country information that may be obtained from all sources whatever; that is, I think a central organization of that kind should, to some extent, be a medium of transmitting from one to the other all the best thought and the improvements that have been brought forward. As it is at present with your association here in Philadelphia, your papers are discussed and published in some of the journals, but other foundrymen in the country have not the benefit of those papers and discussions that you obtain. On the other hand, discussions that are going on at other associations—the Texas, the Western and others—do not come to your hands. I believe the main object which a central organization should take in hand would be to disseminate the information gathered from a much larger constituency, for the benefit of that constituency in all ways. And I believe if that is made the leading feature that action can be taken placing us in position to work harmoniously; and I believe that action can be taken whereby the operations of the various foundrymen's associations in this country may be sent to this central organization for distribution all over, and that means you will serve the greatest good; but I am of the opinion that if you attempt to go beyond that you will create a number of divisions in your work, which will hinder the fullest development that you will get out of such an organization.

Mr. Frank A. Magee, Boston:—I believe in an organization; I believe in it from the fact that it brings the manufacturers to touch elbows; and I believe in the social side of it—it brings them together that they may become acquainted with each other. But I have little to say on the subject. We have had so many good papers on it already that the ground has been practically covered. I am reminded of a little incident that happened during the past winter, which I will relate by way of illustration. I was in California with my wife; we have a boy—a youngster of some twelve years of age. One day we received two letters from him, one for

my wife and one for me. The one to my wife was very interesting indeed. I opened the one directed to me and it was this : "Dear papa, I have written a long letter to mamma, and I can only say 'ditto' to you." And so I can only say "ditto" to what I have already heard. (Laughter.)

Mr. Jas. A. Beckett, Hoosick Falls, N. Y.:—I am highly in accord with the ideas expressed here with regard to the organization. I have no doubt that the foundry business at large has been limited by the existing conditions which have been brought out here, and I believe that an organization of the character proposed cannot fail to be beneficial in the way of enlightenment and interchange of ideas. I think that the ground involved in this present discussion will be well covered if the gentlemen present from localities in which foundrymen's associations have already been formed, will express their views in the matter, and it will do away with the suspicion or question as to the propriety of organizing a national association of individuals without the consent of the different associations which have occupied parts of the territory of this country. I think from the very fact that the different associations now organized are only able to reach a limited number of people—and that mainly through the medium of the public press—that the members of a national association, if formed, will be well recompensed for the time they spend, in the benefits they will receive in exchanging ideas among the most progressive foundrymen of the age. As I am not included in the territories which are now covered by the Foundrymen's Association I am not in a position to say anything beyond what I have expressed, but I am in favor of the organization. I would be glad to hear from the gentlemen from the New England, also from the Southern and Western Associations, as to the propriety of forming such an organization.

Mr. H. M. Lane, Cincinnati, O.:—I have no information to give, but I want to ask a question. Since coming into the hall I have seen many familiar faces, most of whom belong to the American Society of Mechanical Engineers. The question has occurred to me as to whether the American Society of Mechanical Engineers does not cover all the ground that has been suggested for this

association. I want to ask whether the members here are not eligible to membership in the Society of Mechanical Engineers, and whether the objects of the two associations would not be better met by an organization as central as the American Society of Mechanical Engineers. I ask that as a question. I see many members of that society here. I would like to hear from anybody on that point.

Mr. West, Sharpsville, Pa.:—I cannot see that the suggestion offered by the gentleman from Cincinnati would result in any practical advantage. The first thing we want to do is to organize, and not to think too much ahead; we are not here to try to plan what we are going to do in the future. After we get started I think then the different sections or branches of our business ought to be brought together under classified heads. I don't see that any foreign association can be brought into it very well. We want to act independently, and I think if we organize and go ahead that we will surprise ourselves in the end the same as the members of the Philadelphia Association have done here.

Mr. C. S. Bell, Hillsboro, O.:—It seems to me that, if the purpose of this organization is simply that of social intercourse, this country is too large to entertain that idea to any degree of complacency. If it is the intention of this convention to organize a national association that shall be half composed of delegates or such representatives as may be selected by local organizations, I can see the utility of it; or if it is the purpose of this convention and the foundrymen here congregated to organize such a system of work as shall include the organization of local industries in the large cities, so that the information gathered from the whole can, through these organizations, be disseminated, and thus make a compact national association out of our local associations, why, it seems to me that it is the proper idea. My query is, what is the purpose of this convention? Is it to organize a national association independent of all other associations, or is it to disseminate information gathered by local organizations?

Mr. S. G. Flagg, Philadelphia:—I was responsible for raising this discussion, and I want to offer a few words in explanation.

One gentleman from Pittsburg took a very active interest in this convention—took the trouble to go around the city to the various foundries, and on presenting the matter to them the invariable answer was: "No; we have had enough to do with foundrymen's associations; we have had one here and we don't want to go into another." Now, then, the point is this: Why did the Pittsburg Association fail? A gentleman in the room can tell you. When they organized as manufacturers the purpose was to regulate prices. They would meet on certain occasions, discuss the subject of wages, the question of the price of castings, and there would seem to be an understanding arrived at as to prices, but the moment they came into competition on some important work the members said, "No, we want to keep the work in our own shops." I am led to believe that the question of the regulation of prices or the regulation of the question of wages should have no part in the proceedings of the proposed organization, but that we should come together to discuss the best methods of foundry appliances, the best methods of molding, etc. I believe immense good will be done in this way, but if it is decided to fall back quietly into the question of prices the organization will fail, because human nature is too weak and cannot stand the step.

Mr. C. A. Treat, Hannibal, Mo.:—It would be somewhat superfluous for me to try to educate the foundrymen of the east. The ideas expressed by the gentleman seem to strike me as the most forcible of any that I have heard; that is, if you get up an organization it should be an organization for education and not for control. But at the same time I don't know how you are going to harmonize these things. You have got an organization of foundrymen in the west and one here in Philadelphia, and they might not like to come into a national organization; they might want to continue the way they are. But if you form an organization for education I can see the usefulness of it.

Mr. W. H. Pfahler:—I am very much interested in what has been said by the gentlemen. It is unnecessary for me to state that I am heartily in accord with the sentiments expressed. If organization is what we want, let us bring it about, and bring it about without attempting to regulate prices—bring it about for

just what the gentleman has said—educating every foundryman of this country to a higher level in the business. The man who puts his efforts in his business is going to get more out of it than the man who don't.

The Chairman:—As the Chair understands the subject, the question before us is to create an organization. After having created an organization, the policy of the organization can then be outlined. It seems to me like a waste of time to discuss at this point what the organization is to do when we have as yet no organization. Do we admit the expediency of an organization? If there is no unanimity on that point, of course the matter will be a failure; but I question whether there is a man in this room who does not feel that there is a necessity of organizing. The conditions surrounding us are concentrated capital on the one hand and scattered and disunited capital on the other. If you don't organize, you must go to the wall. Whether we do it to-day or in ten years hence, that is immaterial. Do we need organization? The points suggested as to the educational features are, of course, one of the things to be considered. No one here would attempt to control prices. That would be ridiculous. That goes without saying. What we want is to create respect for each other, to aspire for the confidence and good will of our fellow-foundrymen.

Mr. F. B. Schaffer, Elizabethport, N. J.:—This being my first appearance in a meeting of this kind, I just want simply to say this: Since the formation of the Philadelphia Foundrymen's Association I have been a constant reader of its proceedings, and have been benefited thereby to an extent that it would be impossible for me to state. Since the Western Association has been formed I have been a reader of its proceedings, and I believe that a national association on the part of the foundrymen of this country would be one of the grandest things that could occur, that is, if it is organized for the purpose of enlightening each other as to the best methods of performing the work and managing men and foundries—and I don't mean by "managing men" the idea of "driving" them. I will repeat my conviction, that I believe a national organization of this kind would be a grand and good

thing, and I hope before leaving the city to have the opportunity of inscribing my name upon the register of members of the "National Foundrymen's Association of America."

Mr. S. G. Flagg, Jr.:—We of the Philadelphia or Eastern Association came here as individuals, not as members of any organization or any association, and I understand the various gentlemen came here as we do, as individuals. It is our intention to ascertain the sense of the meeting composed of these gentlemen, as to whether they, as individuals, are interested in the formation of such an organization. It struck me at the time that the resolution was presented that it was rather too hasty and was voted on thoughtlessly. It seemed to me that we did not quite appreciate what we were voting for. It would seem to me that the object for us to determine now is whether it is the sense of the meeting that we do organize or not. If we take a vote of that kind and if we decide that it is, then I think we can go into the consideration of the question of a Constitution and By-Laws, and other subjects with a great deal more feeling and a great deal more encouragement, and more harmoniously. I make a motion to ascertain whether it is the sense of this meeting that we organize. If we go to the labor of making a report, and it is not the wish of the gentlemen that we go that far, it is a waste of time; we had better spend the rest of the time in entertaining our visitors and send them home with a better opinion of us, perhaps, than if we had organized.

The Chairman:—The resolution is still before the house.

Mr. Flagg:—If I understand it rightly, the motion to reconsider was carried, and we are discussing the resolutions.

The Chairman:—Yes, sir; we are discussing these resolutions. Your motion is practically embodied in these resolutions.

Mr. Flagg:—Do all the gentlemen understand that in voting on these resolutions we voice the sentiment that we do wish to organize?

The Chairman:—Your remarks give me a thought. Suppose we withdraw these elaborate resolutions and just have a simple motion to organize. How would that strike you?

Mr. West:—I think I get Mr. Flagg's idea. He wants to see if the members present understand now what we are talking about; and it seems they didn't when the motion was first brought before the house.

Mr. Flagg:—I move that it is the sense of this meeting that we organize. I call for a rising vote.

Mr. Flagg's motion was duly seconded; a rising vote was taken, and the motion unanimously carried.

Mr. John A. Penton, Detroit:—There are quite a number of us here who are not acquainted with all those appointed on the Committees on Constitution and By-Laws and Nominations. That being the case, all the care, time and study possible should be given, in order that the best available men in the country may be selected; so I think the report of the committees should be made the very last thing in the session, in order to give them as much time and consideration as possible.

The Secretary:—Gentlemen, would you like to have the roster read in your hearing, so that you may know who is here?

Mr. Wood:—Before we go into any further discussions, I move that the Chair fix the time that these committees shall report.

Mr. Wood's motion was duly seconded and carried.

The Chairman:—The Committees on Constitution and Nominations will report at the end of the business session to-morrow.

Mr. Brown, Philadelphia:—I would like to inquire if the President to be elected is to be the president of this convention or the permanent president of the permanent organization.

The Chairman:—At present we are only a temporary organization. A committee has been appointed to offer names for officers. These officers, as soon as they are elected, will take charge of the convention, even at this present session in Philadelphia, and will be the officers of the future conventions until their successors are elected. This, however, is only my general idea—following the usual custom of conventions.

Mr. Jerome Weyhenmeyer:—I think that all understand that organizations of this kind must have a beginning, and it must be

temporary; all organizations of this kind would elect their officers at the end of the session for the purpose of transacting business for the next year, for semi-annual report, or whenever they thought proper to meet. The elective officers ought to be elected at the end of the session, and they should take charge at the next session. This meeting can be carried on temporarily until you come to the close, and then you will elect officers, for the reason that you are electing men whom you know. It would be useless for men to vote for somebody with whom they are not acquainted. This is a national affair, and there are a great many men interested in it. I think it would be well to leave that part of the business until the end of the session, and act temporarily in the meantime.

The Secretary then read cordial letters of invitation to those attending the convention as follows:

From the Philadelphia Bourse, inviting all to visit its building.

From the Master Builders' Exchange, inviting delegates to visit their building and exhibition room.

From Reihle Brothers, inviting all to visit their works at any time.

From the Manufacturers' Club, extending to all present the courtesies of the club.

From the Board of Directors of the City Trusts, inviting all present to visit the Girard College and grounds.

After Mr. C. T. Holbrook, the Sergeant-at-Arms, had read the roster of the delegates present, the Chairman announced that the evening session would be held at the Franklin Institute, and the session adjourned.

SECOND SESSION.

PHILADELPHIA, Tuesday, May 12, 1896 (8 P. M.)
FRANKLIN INSTITUTE,

The Chairman introduced Dr. W. H. Wahl, who spoke as follows:

Mr. Chairman and Gentlemen:—I think it is in strict accordance with the eternal fitness of things that an association like yours should hold a portion of its sessions at least in the hall of

the Franklin Institute which for three-quarters of a century has been dedicated to the progress of the useful arts. Our motto here is science and progress. It is also yours. I trust the work of your association which you are about inaugurating will prove a great success. This is an age of associations—associations of business men of all kinds, and it is no less so in the domain of science and the useful arts.

I would like to express, on behalf of the Board of Managers of the Franklin Institute, our courtesies to you and our best wishes, and I trust you will make yourselves at home during the remainder of the session, taking a little of your time in examining the relics and other things here. I extend to you a cordial welcome on behalf of the board of managers.

The Chairman then introduced Mr. A. E. Outerbridge, Jr., of William Sellers & Co., Incorporated, Philadelphia, who read a paper on the subject,

"FOUNDRY CRANES, WITH THE DIFFERENT METHODS OF DRIVING THEM."

and gave lantern illustrations of the various cranes described.

Mr. Outerbridge prefaced his paper by the following remarks:

Mr. Chairman and Gentlemen of the Foundrymen's Association:—I can but reiterate the expressions of the Secretary of the Franklin Institute, so pleasantly presented, and also say that it gives me pleasure to meet you in the hall of this venerable institution, which has been the scene of very many notable conventions in past years. It has also been the place where prominent mechanical engineers and scientists, both from abroad and at home, have been pleased and proud to meet and to speak. It is also the place which may almost claim to be the birthplace of many of the famous discoveries and inventions of which we are now reaping the benefit. It is, at least, the place where many discoveries and inventions within my own recollection were first introduced to public notice, such as the now familiar incandescent electric light, which was the occasion of a great meeting some years ago; the introduction of the phonograph—the first word

that it whispered into the public ear, if I am correct, was heard in this hall. I might say, in respect to the Franklin Institute that I have some claim to feel sufficiently at home here to treat you as my guests for the time being, having almost grown up within its walls, and having been connected with it for a quarter of a century.

About three years ago I was invited by the Secretary of this Institute to give an address before its members, at one of the monthly meetings, upon the subject of "the modern traveling crane." I am now called upon to address a much more critical audience, composed of practical foundrymen, many of whom, I have no doubt, are more familiar with the operation of cranes than I am, and all of whom are, presumably, on the qui vive to learn anything new, and ready and able to criticise expressions of opinion that may differ from their experience or theories; and I am perhaps still further hampered—not embarrassed, but limited—by a feeling that it would not be quite within the bounds of propriety should I express my personal bias, or opinion, as to the relative merits of cranes of different makers, or even of different forms of cranes by any one maker; but in thinking it over, it appeared to me that my proper function this evening would be to act as a sort of master of ceremonies—some one to introduce the subject to you for your consideration, and possibly for your future consultation and discussion, for I presume that, as there are others here this evening to follow me, there will not be much time left for discussion to-night.

My plan, so far as I have a plan, is, therefore, to outline the history of the subject—for it has a history, an interesting history, and a very much more ancient one than most busy, practical men, like those present, are aware of. Having touched very briefly upon the early history, it would seem proper to consider the general underlying fundamental principles upon which the construction of all cranes should rest. Then, having reviewed the various primitive forms of cranes, eventually coming to the modern type—showing the gradual steps—the evolution of the modern foundry crane will be finally reached, which, in its complete and perfect form, is one of the most remarkable labor-saving

inventions of the present day. Yea, more than that, it is an appliance without whose aid much of the work that is easily done to-day could not be profitably undertaken at all.

We may readily believe that one of the earliest necessities of the primitive founder was some form of apparatus for handling his heavy materials, and crude appliances for this purpose are known to have existed from a very early period. It may, however, surprise those who have not investigated the subject historically to learn that records are extant showing that even the Egyptians possessed elaborately constructed derricks and other hoisting appliances.

A gentleman who recently returned from an extended tour in that land of antiquity informed me that one of the most interesting places that he visited in Egypt was a large chamber or vault in the interior of one of the pyramids which contained the sarcophagus of the king who caused its construction.

The walls of this room were lined with large slabs of stone, upon which were carved in low relief hundreds of figures, illustrating the method of constructing the pyramid, including the quarrying of the stone. Although my friend is not a mechanic, he said that the representations of derricks and other apparatus, with winches, ropes, etc., for hoisting and moving the large stones resembled many of the appliances for similar uses which may be seen in parts of Europe even at this day.

These carvings are more than four thousand years old, and are as sharply defined as when fresh from the graver's tool; even the original faint tracings of the artist could be detected in some instances.*

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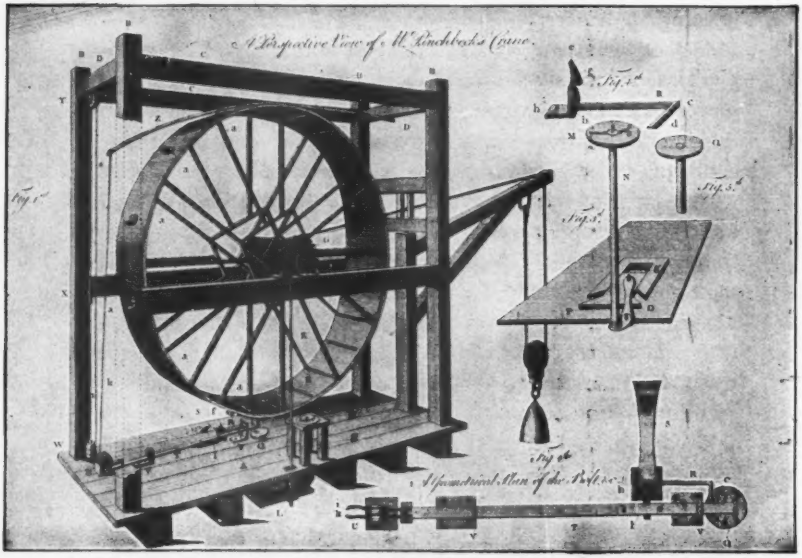
*Mr. Ferguson, in his "History of Architecture" (Vol. I, pp. 91, 92), says: "No one can possibly examine the interior of the great pyramid (Cheops) without being struck with astonishment at the wonderful mechanical skill displayed in its construction. The immense blocks of granite brought from Syene, a distance of 500 miles, are polished like glass, and so fitted that the joints can scarcely be detected.

"Nothing can be more wonderful than the extraordinary amount of knowledge displayed in the construction of the discharging chambers over the roof of the principal apartment, in the alignment of the sloping galleries, in the provision of ventilating shafts and in all the wonderful contrivances of the structure. . . . Nothing more perfect mechanically has ever been erected since that time."

Coming down to a comparatively modern period, I will be able to show you upon the screen a photograph of an ancient drawing of a crane devised by an English mechanic, Mr. Pinchbeck, which was examined by a committee of the "Society of Arts" of London, and to which the society's gold medal was awarded in the year 1767.

Such a crane would excite attention as a novelty, even at this day. This picture will serve to establish the "state of the art" at that date, and afford a starting point for a brief survey of the



ground which has been covered in the past century, but more especially within the past decade.

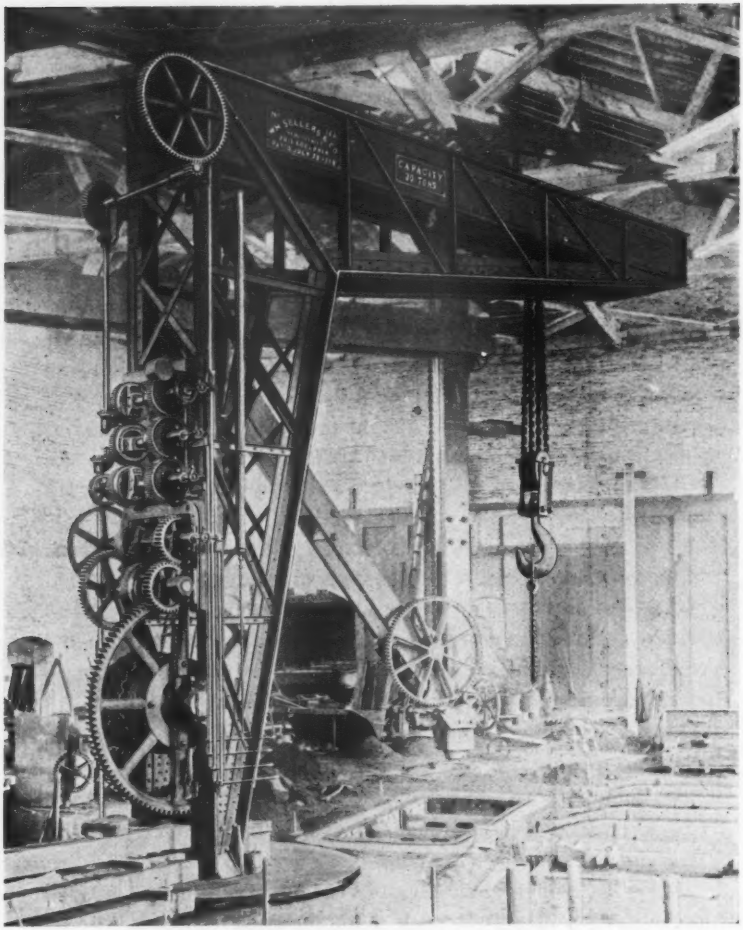
I find that while there are many references to cranes in text-books on mechanics, there is almost no literature devoted exclusively to this subject, and the ephemeral magazine articles, which appear from time to time, are mainly descriptions of new special apparatus. The impression might be gained from a perusal of these papers that the "swing" or "jib" crane is now almost

obsolete, having been superseded by the modern "traveling crane." There are two erroneous impressions contained in such a conclusion; first, the jib crane is by no means obsolete, nor is it likely to become so in our day; second, the traveling crane is not so novel an appliance as many mechanics suppose. In this city, and within almost a stone's throw of this building, overhead travelers were constructed and erected in a machine shop more than forty years ago, and have been continuously and successfully operated ever since that time.

It is true that the constantly increasing magnitude of engineering constructions, and the need of economy of time and labor in handling heavy materials used in such constructions, has stimulated invention and has produced improvements in design and construction, which have enormously increased the efficiency of traveling cranes, and have caused them, in many instances, to supersede the swing cranes, which are more limited in their sphere of action. On the other hand, there are many situations which are not well adapted to the economical use of travelers, where "jib" or "swing" cranes are more advantageous, and will therefore continue to be used; but, when we compare the modern improved high-speed jib crane—having a light wrought-iron frame, safety clutches, electric motor and other novel appliances—with the cumbersome, old-fashioned wooden prototype, we find that the jib crane, far from becoming obsolete, has been modernized and improved in quite as marked a manner as in the case of the traveling crane.

It is my purpose this evening to present a brief survey of this march of progress, marking the evolution of both "jib" and "traveling" cranes.

There are numerous subdivisions of both classes of cranes, such as "pillar," "column," "derrick" and "locomotive" cranes. Some have rotary motion around a mast or column; some have rectilinear motion in which the load is moved in one or more directions in straight lines. They are, moreover, designated as "hand," "power," "steam," "pneumatic," "hydraulic," "electric," according to the particular motive power.



30-TON STEAM JIB-CRANE.

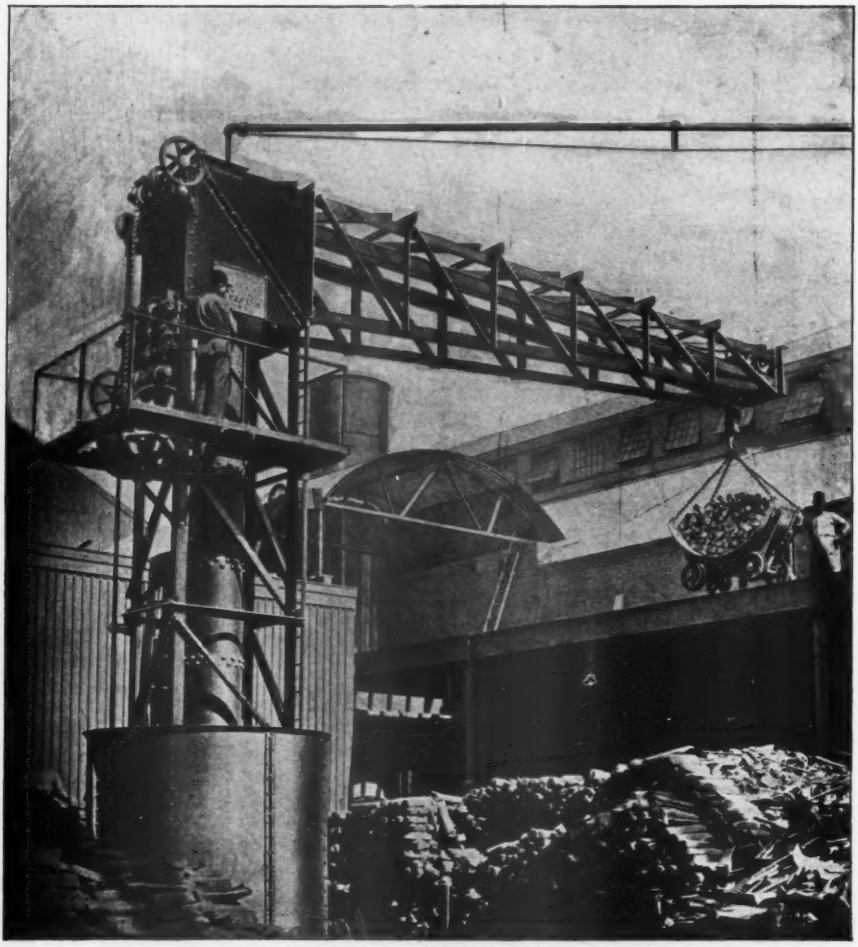
Height of post, 26 feet; effective radius of hook, 23 feet. All movements by power. Driven by independent 8x8 feet engines, bolted to frame carrying machinery, receiving steam through upper pintle and discharging exhaust through step in foundation plate.

There are certain fundamental principles which are applicable to all cranes. The first and most important consideration in a machine designed to transport enormously heavy materials over the heads of workmen, is the factor of safety.

The second important consideration is that of speed, in which the ability to reach the load to be moved in the shortest possible time, whereby the preliminary operations of getting ready to lift are materially hastened, must be combined with a steady motion when hoisting the load, free from jar, and susceptible of the most delicate adjustment.

The third consideration, largely a consequence of the second, is that of economy of operation. This implies, in addition to quickness of movement, the judicious location of all working parts within easy sight and reach for facilitating oiling, tightening of nuts, etc., by the attendant when not operating the levers; ease with which parts may be removed for repairs, together with ample proportions of each piece in its proper relation to the whole, all tending to minimize the cost of maintenance.

The functions of the jib and of the traveling crane, while sometimes overlapping, are more often quite distinct. It may be said, in a general way, that in foundries where heavy castings are made, necessitating the handling of long flasks, large cores and immense ladles of molten metal, the overhead traveling crane, occupying no floor space and performing the work of a number of jib cranes more expeditiously, presents economic advantages of such importance that it has now come into almost universal use. In establishments where miscellaneous work, of comparatively light weight, requiring frequent service by molders for short intervals of time, of a quick hoisting apparatus of moderate capacity, the modern jib crane presents superior advantages; in not a few foundries a combination of jib and traveling cranes is found very economical. That these differences are understood and appreciated in large manufactories is well exemplified in the Baldwin Locomotive Works, where you may see in daily operation in the different departments the latest forms both of jib and traveling cranes.



5-TON STEAM PILLAR JIB-CRANE.

Carried upon riveted steel pillar, bolted to foundation, driven by independent steam engine, and receiving steam from stationary boiler through top pintle bearing; post of crane protected by cylindrical guard. Operating platform elevated. Maximum height of hook, 25 feet. Effective radius of hook, 30 feet.

There are local conditions which also exert influence in determining the relative value of jib or traveling cranes. A long narrow foundry, where molds are situated at a distance from the cupola, is better adapted to the use of traveling cranes than a foundry of different shape, where the molders' floors are, perhaps, laid out in circles, and each molder is more conveniently served by an independent jib crane, with its post in the center of his floor.

I may cite, as an evidence of the comparative economy resulting from such appropriate arrangements, an instance coming under my own observation, where in one car-wheel foundry, twenty wheels 33 inches in diameter, make the usual day's work of a molder, while ten molds in another similar establishment, without equal modern facilities, constitute the usual day's work, the only important difference between the two being in the superior facilities for handling flasks and wheels in the first-named case.*

The old-fashioned jib crane was an exceedingly clumsy construction of timbers bolted together, braced with wrought-iron rods and capped with iron castings. This composite structure was not only cumbersome in appearance and slow of motion, but it was subject to deterioration through shrinkage and decay, caused by heat, cold and dampness. Such structures are indeed obsolete to-day, but they have been replaced by jib cranes having a light framework of wrought iron, scientifically constructed, advantage having been taken of the great improvements and economics which have occurred in the manufacture of structural iron in recent years.

The tendency to follow in beaten tracks was evident, even after iron was substituted for wooden frames, but it was soon found that the rapid rotation, as well as quick hoisting required in modern cranes, demanded an entirely different structure, having much greater torsional stiffness. A basket framework of

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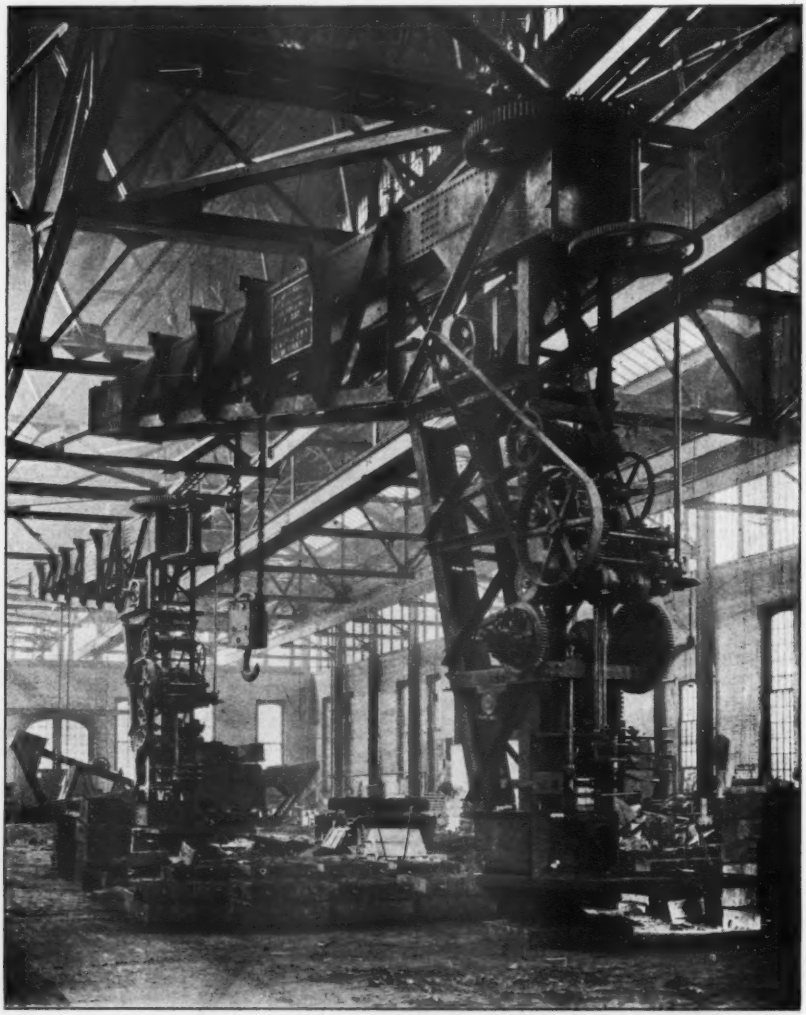
*A recent editorial in London Engineering, March 6th, entitled "Panaceas for Labor Strikes," instances the case of two shipyards side by side, in one of which steam derricks are used for plating, and the price paid is 8 shillings per plate, whereas, in the other yard, the plates have to be lifted by manual labor, and the employer has to pay for the same size of plate 8s. 6d. "It is surprising that any firm should be without steam derricks, and there is little wonder that the men getting 8s. 6d. a plate earn less wages than those paid 8s."



10-TON ELECTRIC JIB-CRANE.

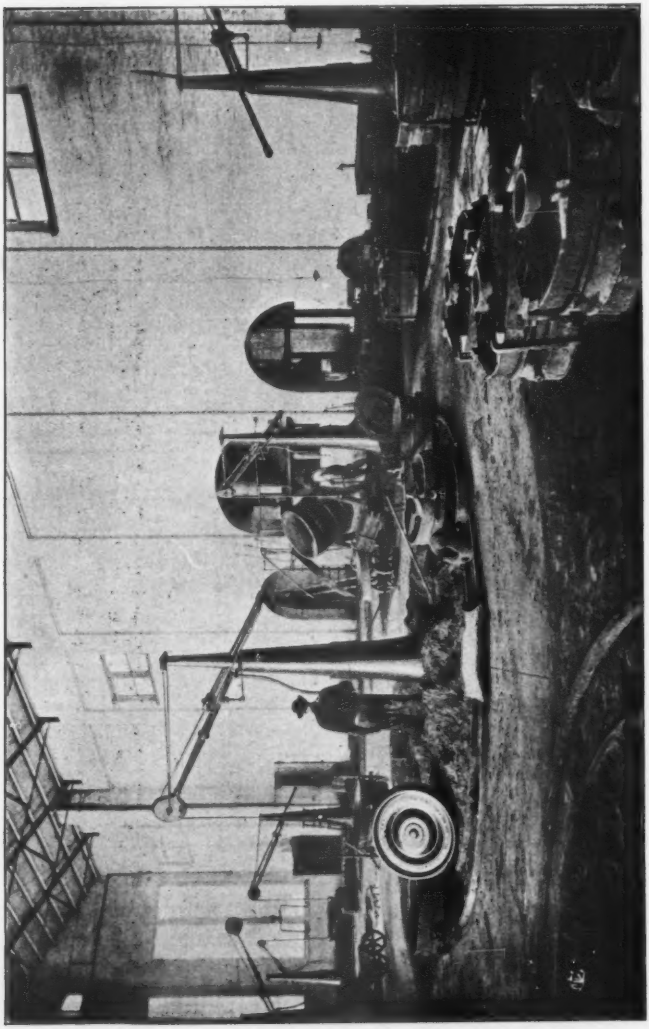
With two hoisting speeds. Effective radius of jib, 30 feet. Operated by single constant speed motor. Arranged to lower by power or brake, as may be required.

lattice girders, having both lightness and strength, was then substituted for "I" beams or channel bars, and, in the improved type, the trolley, or carriage, travels within the framework of the jib, which is additionally strengthened by cross bracing across the top. The post is latticed and cross braced on all four sides in the same manner, and wide plates are used to strongly unite the parts of the frame both at the top and bottom. The absence of a diagonal strut, such as is necessary in the old-fashioned wooden jib cranes, permits the work to be moved much nearer to the axis of rotation than was formerly possible.

Jib cranes may be supported at the top by bearings attached to the roof girders, by struts from the walls, or they may be made to embrace columns which support the floor of the building, or the column may be a pillar secured to a sufficient foundation requiring no support from roof or wall. In some forms of swing cranes the jib may be raised or lowered to increase or diminish the diameter of the circle.

In addition to those forms of cranes which I have described, there are a large variety of smaller hoists, operated by hand as well as by pneumatic, steam, hydraulic and electric powers. Some of these are specially designed as attachments to machine tools, for lifting heavy work; others are used for raising and turning over flasks in moulding; others are mounted on trucks and are especially designed for work in car-wheel foundries. Indeed, the variety of special uses for small cranes is almost without limit, and in all great improvements have been made both in quickness of movement and in lightness of construction.

Foundrymen in America have, as a rule, been content with the simplest and cheapest forms of hoisting appliances which the character of their work would permit, but recently much more attention has been paid to improvement in the crane facilities of foundries and machine shops. This has been due, in part, to competition, which has compelled manufacturers to consider economy in every detail of their work and methods, and in part to the fact that crane builders have developed and improved foundry cranes, so that it is possible now to procure much more perfect machines of this character than could be obtained a few years



VIEW IN CAR WHEEL FOUNDRY OF PENNSYLVANIA RAILROAD, SHOWING HYDRAULIC MOLDING CRANES AND LADLE-TILTING DEVICE.

ago. The electric motor has played a very important part in this development, since it affords a most convenient method of conveying power to a moving machine, like a crane.

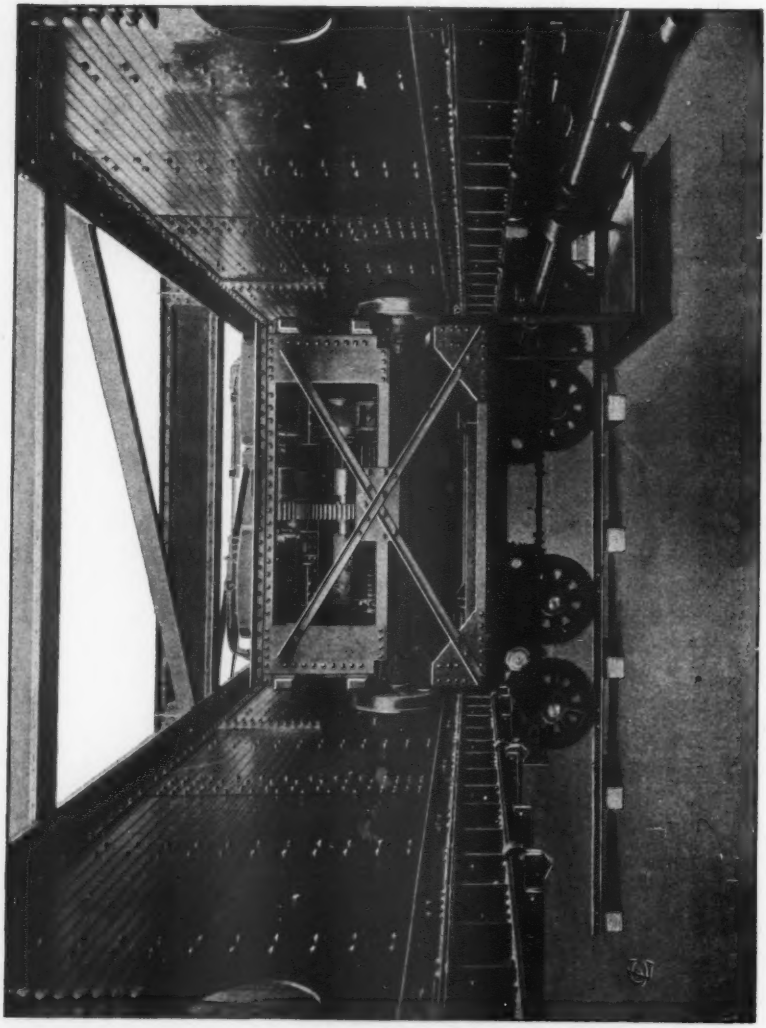
The first marked improvements in swing cranes were in the direction of applying power, either steam or hydraulic, and, for some purposes (noticeably for Bessemer steel making) such cranes were carried to a high degree of convenience and efficiency. The swing crane, though well adapted to work where the weights to be lifted are confined to the area covered by the crane—as in a pipe foundry or Bessemer steel pit—is not so convenient when it becomes necessary to handle product of varying size and shape, and to transfer such pieces rapidly from one end of a foundry, or shop, to another.

The time lost in adjusting chains and the inconvenience of reserving floor space for temporary resting places for such objects in transitu constitute objections to the swing crane under which many manufacturers are unwilling to continue to labor when it is no longer necessary. The traveling crane, covering as it does all the available space beneath it, if properly designed, does the work of many swing cranes.

Passing on to the study of traveling cranes, we find that while overhead travelers have been used for many years, they were formerly crude devices, originally having wooden bridges, requiring much splicing for long spans, besides trussing and bolting to add greater strength. They were usually operated by ropes or by independent engines.

These old traveling cranes were necessarily very slow in movement, and the improvements which have rapidly followed the substitution of iron girders for wooden trusses, mechanical—or still more recently—electrical power for hand movement, with addition of quick-running gearing, increased lifting capacity, friction clutches, and other safety devices, etc., etc., have combined to produce practically a new machine and an invaluable aid to the founder or other manufacturer.

Various devices have, at times, been applied to conveying power to a traveling crane. Ropes, square shafts, grooved shafts, belts, compressed air, steam and hydraulic power have all been



150-TON ELECTRIC TRAVELLING CRANE.

This crane is operated with independent motors for each movement. The plate represents the interior of the bridge, and shows one of the trolleys in position. Capacity of trolleys, 75 tons each.

tried and are still, to some extent, used, but it was found that to operate heavy cranes at reasonably high speeds, the rope drive was entirely inadequate, and to transfer the necessary power by square shaft requires either a very large shaft or a very high rate of speed and consequent large waste of power by friction. Then again, the shaft revolves continuously, while the crane is operated at irregular intervals, often with long periods of rest, during which the shaft is absorbing an abnormally large share of power in the foundry or machine shop.

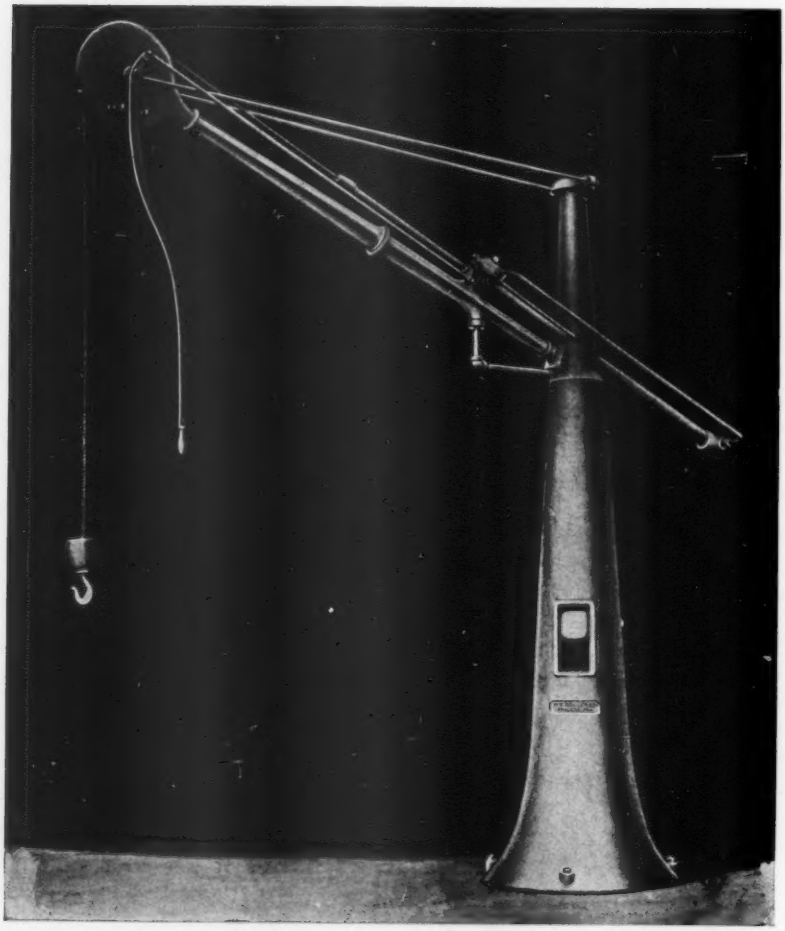
The electric motor has solved many of these problems, and it is now practicable to make traveling cranes which operate successfully and economically at speeds which would have been regarded as impossible by foundrymen ten years ago. Electricity is applied to cranes in various ways: Thus, a motor may be used for each of the motions that it is desired to produce, the speed and duration of each movement being governed by controlling and stopping the speed of the motors. These are called "three motor" or "all electric" cranes, while others are operated by machinery situated at a fixed point on the bridge, and driven by a constant speed motor, the various movements being controlled and regulated by a system of clutches and mechanical transmission devices.

In the "all electric" type, the machinery, the motor and the load are started from a condition of rest. In the latter case the motor and that portion of the machinery which is running while the crane is in service, act as a fly-wheel to assist in starting the load, with the result that there is less demand for current—in cranes of this type—at the moment of starting than in the former.

Before proceeding to describe in detail the various parts of traveling cranes it may be well to pause for a moment to consider what are some of the essential qualifications of the perfect foundry crane. These considerations will apply equally well to all cranes.

I have already adverted to the necessity of absolute safety under all conceivable conditions. This implies that the load can never run down; it must always be pushed down by the hand of the attendant, so that, if, in a moment of danger or excitement, he should suddenly desert his post, the load will remain automatically held until released by the operator.

This crane is operated with independent motors for each movement. The plate represents the interior of the bridge, and shows one of the trolleys in position. Capacity of trolleys, 75 tons each.



1-TON HYDRAULIC PILLAR CRANE.

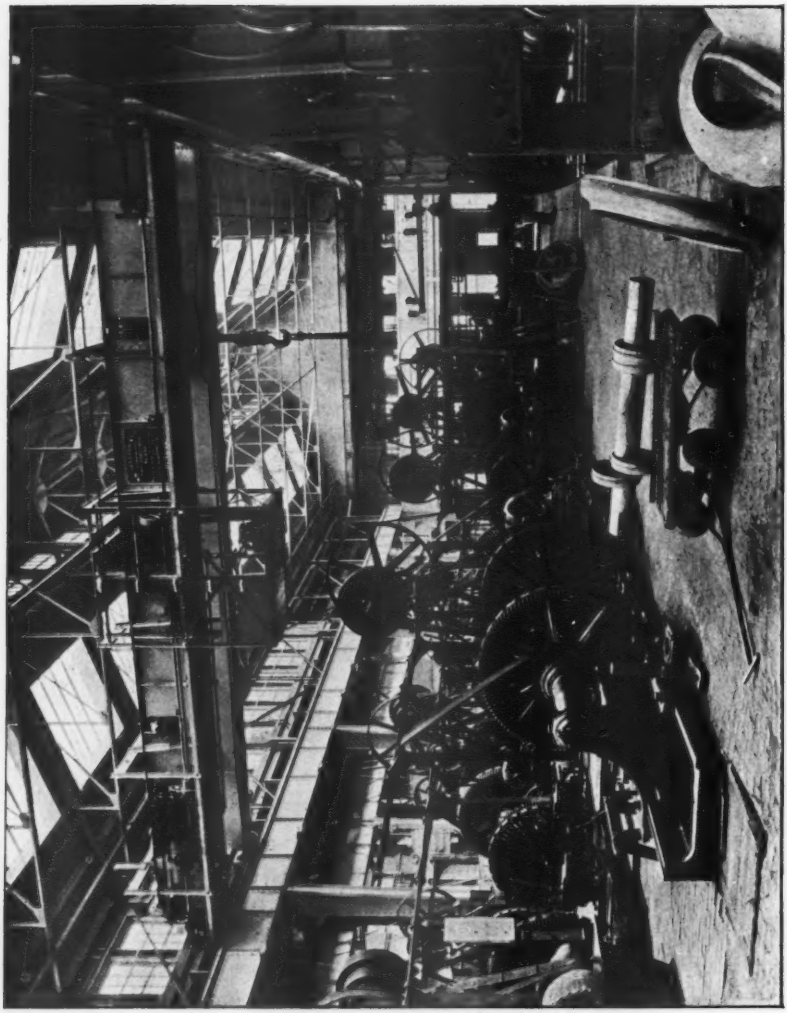
The perfect crane must, moreover, move easily, stop and start gently, and must hoist vertically, no matter how many links of chain are paid out from the drum, so that the delicate operations of the foundry, such as raising, turning over, and closing long flasks, etc., may be accomplished with absolute certainty. Every founder realizes the importance of these conditions not only in the specific operations named, but in others—such as in the setting of large cores, drawing of patterns, etc.—they are even more imperative.

It would perhaps appear at first sight impracticable for one traveling crane to attend to the wants of a number of molders in handling molds and cores, and more particularly at "pouring off" hour, when ladles of molten iron must be handled without loss of time. Experience has shown that, under average conditions, one good modern traveling crane meets these severe requirements; it is certainly a tribute to its inherent capabilities that this should be the fact. Something, however, should be credited to the foundry foreman in this respect, for a clever man can modify the routine methods to suit the new conditions, so that these difficulties soon vanish and are forgotten, like many other ancient customs.

The elevated railway traveling crane, as now constructed, consists of four essential parts:—

1. The elevated tracks.
2. The traveling bridge.
3. The trolley car, traversing the bridge and carrying the hoisting mechanism.
4. The motor or driving mechanism.

The elevated tracks are supported by columns, or, in buildings specially constructed they are sometimes built in and supported by the walls. These tracks run parallel to, and close to, the walls from one end of the building to the other. The bridge is constructed of two parallel girders extending from rail to rail, spanning in mid-air the breadth of the building. Four double flanged wheels, usually steel-tired, with steel axles running in bearings, are bolted to projections on the girders.



10-TON TRAVELLING CRANE.

Driven by single motor and operated from hanging platform in the center. Span, 48 feet.

The trolley car, also provided with double flanged wheels, runs upon steel rails laid within or upon the bridge and bolted securely thereto. This car is provided with a grooved drum and double chain wound thereon, carrying a forged swivel-hook, mounted securely in a hoisting block, the block being furnished with sheaves through which the chain runs. In some large cranes the hook turns on ball-bearings (more than 600 balls were used in one instance), and it is found that the friction is so reduced by these balls that one man can easily revolve a load of 50 tons, suspended from the hook. By properly arranging the grooves on the drum, and winding the double chain always towards the center, a perfectly vertical lift of the load is assured.

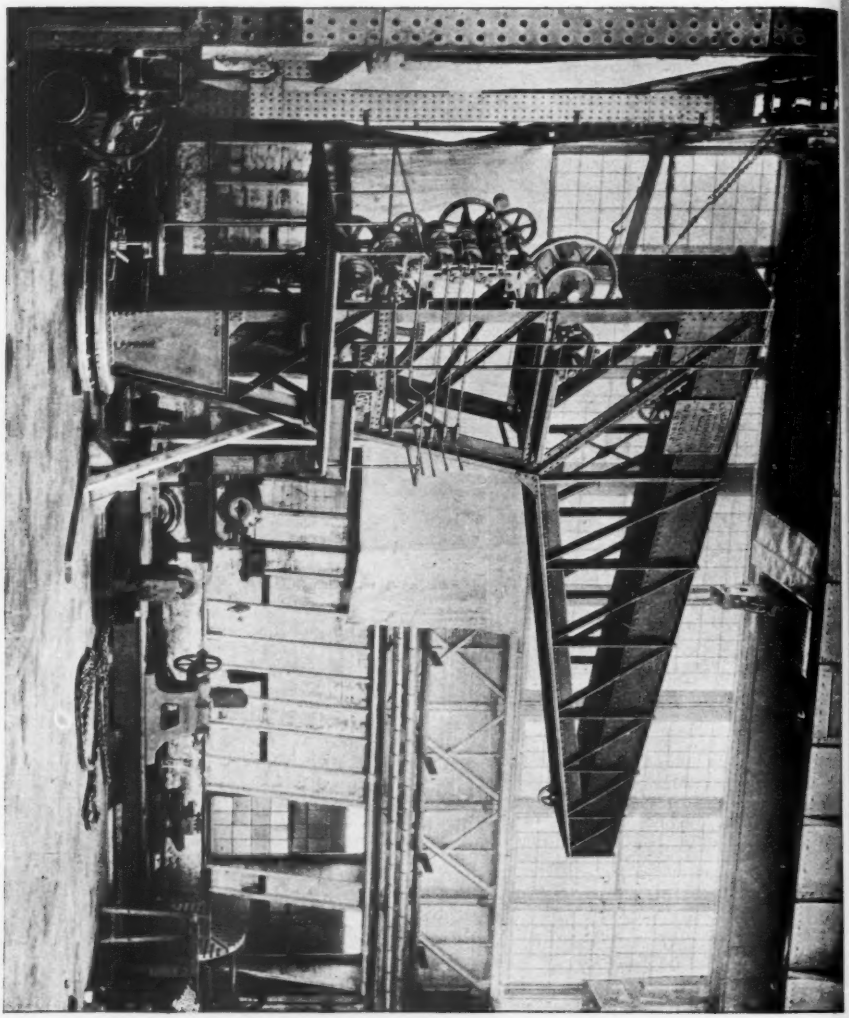
I have carefully endeavored in the foregoing descriptions of jib and traveling cranes to state only the broad general principles underlying this species of mechanism, avoiding allusion to any special features of different makers, or of different designs of any one manufacturer, desiring to treat the subject in as comprehensive a manner as my time will enable me to do.

Reverting to the introductory and historical portion of my address, I promised to show you a picture of an early English "walking crane," so called by reason of the method of operating. I was fortunate enough to find among the rare and valuable old books which are hidden away in the Franklin Institute a beautifully illustrated work, printed in London in 1782, entitled "Machines of the Society of Arts." Through the courtesy of the Secretary I am able to show the illustration of this English crane. I have also obtained a brief and imperfect description of it and a copy of the award, which is as follows:—

"This new invented crane of Mr. Pinchbeck's was referred to the Committee of Mechanics, who was of opinion that this method of preventing fatal accidents (which frequently happens in common walking cranes) is entirely new, ingenious and very effectual for the purposes intended.

"A trial of the crane was made several times at Dices' Key, with an hogshead of potash 6,000 pounds in weight, and it appeared to the committee that the invention will fully answer under all circumstances, and may be constructed at an easy ex-

Driven by single motor and operated from hanging platform in the center. Span, 48 feet.



20-TON ELECTRIC JIB-CRANE.

Effective radius of hook, 31 feet 9 inches. Post, 28 feet high. Elevated platform for operator. Turning-gear at base of post. Driven by single electric motor.

pense. It was therefore recommended to the society, to give Mr. Pinchbeck the gold medal of the society for his ingeniously constructed and useful invention, to which the society agreed on June 3, 1767.

"In the illustration E is a great walking wheel, in which men walk (evidently for hoisting the load). It is 6 feet 4 inches in diameter, and 1 foot 4 inches wide. M is a dial-plate or regulator. The segment of this plate is divided into three equal parts, 1, 2 and 3, with a directing hand by which the motion of the walking wheel is regulated in the following manner: When pointed to No. 1 the aperture g, for discharging the wind out of the bellows, is dilated to its greatest extent to give vent to the wind. When set to No. 3, the aperture is contracted to its smallest dimensions, by which means the upper bellows retain the blast of wind.

"Q is a lifting trundle, passing through the floor, extending so far below it as to be lifted up by the upper board of the receiving bellows, when the walking wheel accidentally revolves with too great velocity. The trundle, latch, sliding bolt and all other movements are at all times in a state of rest until the walking wheel is by some accident violently agitated, and when it so happens the expansion of the bellows will be so far extended as to lift up the trundle, latch," etc.

The Chairman next introduced Mr. C. W. Shields, of the Ingersoll-Sergeant Drill Co., Easton, Pa., who read a paper on the subject:

"THE AIR COMPRESSOR FOR USE IN THE FOUNDRY."

Since compressed air is now produced economically, owing to the many recent improvements made in the design and construction of compressing machinery, the up-to-date plant without its air compressor in the power house is the exception. In the latest and most approved types of compressors the mechanical efficiency has been found under actual working conditions to be as high as 95 per cent., while an efficiency of 85 per cent. or better, is to be obtained in a small compressor suitable for any moderate foundry duty. In order to get the best results from the machines using compressed air it is of the greatest importance that the air supply

shall be constant and ample. To insure this beyond peradventure the compressor must be substantially constructed on the designs shown by the severe test of experience to give the best results. The durability of an air compressor depends largely upon the design of the air parts. As the valves are the most essential feature of an air compressor, it is clear that in order to insure the proper and efficient working of the whole machine the valves must work properly and effectively at all times, and under all conditions. The poppet valve is, perhaps, the most common type employed in air compressor construction, and is used for both inlet and discharge. Inlet valves of this class are very apt to cause endless trouble, particularly when they are located in the cylinder heads, as a broken stem or a loose nut permits the valve, or part of it, to drop into the cylinder. This danger may be obviated to some extent by placing a guard plate on the inside of the cylinder head. This remedy has the objection that it increases the space lost for clearance and slightly restricts the passage of air into the cylinder. In the most approved style of compressor, poppet valves are located in the ends of the cylinder instead of in the heads, and are so placed that they have a vertical instead of a horizontal lift. This arrangement assures an even wear on the valve and its seat and prevents leakage. It also prevents the piston from coming in contact with the valves, and in case of a break the valve cannot be sucked into the cylinder. This disposition of the inlet valves leaves the entire cylinder head free to be fitted with a water jacket or cooling space. It is not practicable to make poppet valves of any great diameter, hence when a large machine is built it is necessary to use a number of valves. This divides the air entering the cylinder into several small streams which pass over heated surfaces, thereby increasing the friction of the air entering the cylinder and decreasing the capacity of the compressor.

By removing the inlet valves from the cylinder head a large cooling surface, equal to about three-fourths of its area, is at once made available. This is more valuable for cooling than the cylinder jacket alone, because the air is hottest after the piston passes the centre of the cylinder; hence we have the hot air

pressed against the cold cylinder head, where it rapidly gives up its heat.

Many of the difficulties and disadvantages have been successfully overcome by the piston inlet valve. This device comprises a hollow tail rod passing through a stuffing box in the back cylinder head, a hollow piston into which the air is admitted through the tail rod and a ring valve of T section on each side of the hollow air piston head. These valves allow the air to pass alternately into each end of the cylinder, and are actuated by means of their own inertia, opening or closing at the moment compression ceases or begins. By means of the piston inlet device a concentrated air inlet current is secured. A suitable sleeve or conduit pipe may be made to conduct to the tail rod inlet air drawn from that source outside of the engine room most favorable to coolness, dryness and freedom from dust or other foreign matter.

Where the load on the compressor varies much it is important that an efficient regulator or governor should be provided which is thoroughly automatic in its action and requiring no attendance.

Under the ordinary conditions existing in foundries a belt-driven compressor is usually more favorably considered than one driven by steam. A belt compressor fitted with a proper regulator absorbs only enough power to meet the demands of the work performed, and being run in connection with other machinery its effect on the coal consumption is not noticeable.

However, in many cases a steam-driven compressor is preferable, because a high-class steam actuated compressor uses steam almost, if not quite, as economically as a shop engine, and whatever loss there may be is more than made up for by the advantages of a steam-driven compressor. With them all shafting and belting are avoided, and the machine can be located in the engine room, where it can be under the care of the engineer. If installed in the foundry the dust and sand have a very appreciable effect upon the bearings and moving parts, and no matter how carefully housed, your compressor cannot be as well taken care of as though it were in the engine room.

Transmission of power by compressed air has the advantage of certainty and regularity in action, simplicity in machinery, freedom from the possibility of fatal accidents, and the assistance given to ventilation and in cooling the shop.

When we come to the question of laying out the piping for a foundry it is well to keep this simple rule in mind. The head necessary to drive the air through the pipe is as the square of the velocity, and to obtain the best results the flow of air through the pipe should not exceed 20 feet per second. If this is borne in mind air can be conveyed almost any distance with little or no loss. In the case of the famous Jeddo tunnel, at Hazleton, Pa., air at 60 pounds pressure was conveyed a distance of 10,680 feet through 5¼-inch pipe, and the gauges showed exactly the same pressure at the end of the pipe as they did at the receiver.

The receiver should be placed in any convenient place and should be of no less capacity than the rating of the compressor in cubic feet of free air per minute. A little thought and attention given to the elimination of turns and angles in the pipe mains will amply repay for the trouble. It is a great economy to lead the air mains centrally and then run small connections to points adjacent and convenient to the place air is to be used. If this is done short lengths of hose pipe can be attached wherever most convenient for connection to hoists, sand sifter or other apparatus, or the air can be used for the same purposes that the bellows and brush are employed for.

The application of the air hoist to cranes may be made in an almost endless variety of ways to meet the requirements of foundries. The most common types are simple cylinder hoists, either vertical or horizontal, or in combination with a low pressure hydraulic system. In many instances direct acting hoists may be readily applied to hand power cranes already in use without in the least interfering with the gearing and at a very small expense.

There is no noise, no jar, and the load is always balanced. In foundries where an overhead traveler cannot be installed air hoists suspended from trolleys running on an overhead track answer very satisfactorily, and if hose couplings similar to those used in connection with the ordinary air brake are provided, by

simply attaching the hose connection after the load is raised the hoist may be run on the overhead track to any desired part of the establishment. This is especially valuable in conveying flasks outside of the foundry to storage sheds, patterns to the pattern shop, or finished castings to the machine shop.

Few of us realize how cheap an air hoist is to operate apart from its convenience and speed in handling loads. It has been estimated by Frank Richards that at 100 pounds gauge pressure compressed air costs 5 cents per 1000 cubic feet of free air.

The following table gives the lifting capacities of direct acting air hoists, with volume of free air per lift, and cost of air per single lift and per 100 lifts, with a maximum lift of 4 feet, and a minimum pressure of 90 pounds, air furnished at 5 cents per 1000 cubic feet of free air:—

2	3.05	274	0.74	$0.000037	$0.0037
3	6.87	618	1.67	.000084	.0084
4	12.22	1,099	2.97	.000149	.0149
5	19.09	1,718	4.64	.000232	.0232
6	27.49	2,474	6.68	.000334	.0334
7	37.42	3,367	9.09	.000455	.0455
8	48.87	4,398	11.88	.000594	.0594
9	61.85	5,566	15.03	.000752	.0752
10	76.36	6,872	18.56	.000928	.0928
11	92.39	8,315	22.46	.001123	.1123
12	109.96	9,896	26.73	.001337	.1337

Air used in combination with a low pressure hydraulic system gives the best results for heavy loads. By interposing the water between the elastic medium, air, and the load, we eliminate that element of danger which otherwise would be present in handling vessels of molten metal, as in foundry practice, and also obtain a sort of elastic positiveness which is so essential and desirable. In the actual work of molding, as in lifting copes and molds, drawing patterns and moving cores, the men are enabled to do about 50 per cent. more work, and do it easier and better, when equipped with a hydro-pneumatic hoist. Included in this percentage is the saving in repairs and the danger of losing castings.

In addition to operating movable hoists, air has proven its value for conveying pig iron to the top of the cupola, and for

breaking up scrap by lifting a heavy weight, which is dropped some 15 or 18 feet. This pig breaker broke three half pigs into three pieces each in one minute, and can easily break 20 tons of pig while a man is breaking up 1 ton by the old sledge method. A portable pneumatic drilling machine for boring holes to weaken stiff castings is used to advantage in connection with this breaker.

The product of a molding machine can be greatly increased if the handling of the sand in shovels is done away with. This is accomplished by an air jet, which at 60 pounds pressure will lift 100 pounds of sand per minute 20 feet high. A ¼-inch nozzle will use 90 cubic feet of free air per minute doing this duty. By elevating the sand to a bin overhead and then conveying it in a chute or pipe directly over the molding machine much time and labor can be saved. A simple slide in the pipe forms a ready means of regulating the amount of sand served to the machine for each mold. In the portable pneumatic sand sifter a small amount of air operates a rotary motor which drives gearing connected to the sieve. Air admitted through a ¼-inch opening at a pressure of 70 pounds develops sufficient power to do the heaviest work.

Recent observation of a molding machine in operation at the foundry of the Ingersoll-Sergeant Drill Co., of Easton, Pa., gave the following figures: On rock drill cylinders, three helpers operating a duplex machine can turn out 22 per day. It formerly took four molders to make this output. In other words, to do the work by hand now being turned out with the aid of the molding machine operated by compressed air would cost 100 per cent. more than is being paid now. On rock drill steam chests the same machine operated by two helpers produces 66 molds per day. Formerly it required three molders to equal this number. In this case it would cost 125 per cent. more to turn out same product by old methods.

The economy of the sand blast for cleaning castings was quite as marked as that of the molding machine. On a flask 30x14x5 inches, made without using any facing, no difficulty was experienced in cleaning 6 square feet of surface per minute. A box bed plate weighing 1,700 pounds was cleaned in one hour by the

blast, while another bed plate made from the same pattern took three hours to clean by hand. With the blast the casting was cleaned so that the chipper did not have to do any cleaning, as he had to do when blast was not used. Neither brushes nor files will get around fins and risers as the blast does. A very difficult casting, with cores that are almost impossible to get out by hand, was cleaned in 45 minutes by the blast, as against 2 hours and 40 minutes by hand.

In this same foundry they formerly melted about 5 tons of iron per day and employed 14 molders, eight core-makers and a cleaning and chipping gang of seven. They have practically doubled their plant and now pour 10 to 12 tons per day, and employ 27 molders, 12 core-makers and a number of labor-saving devices to increase their output, but the same cleaning gang of seven men, with the addition of a sand blast, take care of the product, and the cleaning is done in a much better manner than previously. The sand blast not only effects a great saving in the actual cost of the castings, but a further saving through the removal of the oxide which is so destructive to tools in the machine shop. This saving on tools is most apparent where the work is milled, as cutters can be run at an increased speed. The sand blast applied to the tumbling barrel is an improvement worthy of notice. Aside from the economical features connected with the use of the sand blast, it cleans the castings far better than by hand, and where a casting has intricate steam or air passages it is of the greatest importance to be able to thoroughly clean these inaccessible parts.

Associated with the sand blast, the pneumatic chipper shows to good advantage. These tools were formerly too delicate and complicated for foundry uses, but recent improvements have so simplified their construction that they now have only three pieces in their entire makeup, and but one of these is a moving part.

Dark foundries have found the Wells, Lucigen or some similar light of great use where a cheap intermittent light was needed. In these lamps compressed air forces oil through a nozzle, forming a spray, which, when ignited, gives a flame about 5 inches in diameter and 30 inches long, and about 1000-candle-power.

The air is used at a pressure of from 10 to 30 pounds, and 1 gallon of oil and 60 cubic feet of free air per hour suffice to operate the lamp. These hydrocarbon burners are very useful for skin drying large molds, as well as for lighting.

Breaking test bars from each cast is another use to which air has been applied.

A comparatively small air compressor of proper construction and design will furnish sufficient air for all the needs of a foundry of ordinary size. An illustration in point is a foundry running four cranes of 20, 10, 8 and 1 ton capacity, respectively; a sand blast, two pneumatic chippers, one duplex molding machine and for blowing out and dusting molds in process of construction. In addition, the machine shop uses air for testing small engines and blowing out cylinder ports and inaccessible parts after machining to get rid of oil and chips, and for bench dusting and copying letters in the office. Air at 60 pounds pressure for all these uses was supplied by a 14x16x18 compressor running at 120 revolutions per minute and furnishing about 500 cubic feet of free air per minute.

After the reading of Mr. Shields' paper the Chairman announced that, owing to the lateness of the hour, it would be impossible to take up any other paper at that session, and after a brief discussion an adjournment was taken.

THIRD SESSION.

FRANKLIN INSTITUTE,
Wednesday, May 13, 1896 (10 A. M.)

The session opened in the lecture hall of the Franklin Institute at ten o'clock.

A paper by Charles James, Mec. E., of Henry Disston & Sons, Incorporated, Philadelphia, on "The Chemistry of Iron, with Determinations and Their Value," was read. The paper was accompanied by practical demonstrations of analyses, in which Mr. James was assisted by Dr. W. C. Henderson, of Thos. Devlin & Co., Philadelphia, and Mr. George White, of Henry Disston & Sons. Samples of Bushong, Crane and Thomas irons were adopted as specimens, and determinations of manganese, phos-

phorous, silicon, graphite, sulphur and combined carbon made from them. The apparatus used was a complete duplicate of a working laboratory. The paper was as follows:—

"THE CHEMISTRY OF IRON, WITH DETERMINATIONS AND THEIR VALUE."

Gentlemen:—Permit me to preface this paper by saying that it is written with the idea that foundrymen desire to acquaint themselves with chemical methods and practices, as applied to the analyses of foundry iron, etc., and, that not having time, or, in some instances, not having the inclination, to enter into a long scientific study of the subject, they would welcome a few plain directions for determining the more general constituents of cast iron.

Permit me at the same time to point out that chemistry is not intended to supersede, but only to aid and strengthen practical foundry experience.

First, then, let us understand what is meant by "chemistry." Scientific chemistry is that branch of general knowledge by the principles of which are determined the composition and character of all natural and artificial objects. By it we are able to separate not only the constituents of heterogeneous masses, but even to determine the character and structure of homogeneous substances.

It confers upon its adepts the power to deal with what the eye cannot see nor the hand handle; to separate the molar mass, not only into the intangible molecules but even into the probably immaterial atoms, and to reconstruct these back again into the original compound, or if he so chooses into fresh compounds the physical and chemical characteristics of which shall be totally different from those of the substance from which they originally came. While chemistry is thus the brightest jewel in the crown of science, it is at the same time equally applicable to the requirements of commercial pursuits. Commercial chemistry though rooted and grounded in scientific chemistry, does not, however, call for the time, labor and extreme accuracy of scientific investigations, fair accuracy accompanied by expedition being generally sufficient for all practical and commercial purposes.

To attain, however, even to the accuracy necessary for commercial determinations requires considerable caution and judgment upon the part of the operator and nothing should ever be done carelessly and no detail, however small, should be considered of such little importance that it may be slighted; for any such want of attention will certainly result in faulty determination and misleading errors. From these general remarks we will now turn to that particular branch of chemistry which, as iron founders, especially demands our attention. First, however, let us consider what relation chemical analysis bears to successful iron founding. The chemical analysis of iron, like that of any other substance, is but the hand-writing on the wall, and needs interpretation by the light of practical application before it can become of use to the iron founder. This interpretation is only obtainable by carefully noting and comparing the physical results obtained in the foundry when using iron mixtures, the proportions of the chemical constituents of which have been previously determined by analysis. Thus, every foundryman must still work out his own salvation just as in the old non-scientific days. Chemistry, however, will shed a new light upon his path so that as he runs he may read a lesson, not in the bitter experience of past failures, but in the more economical methods of obtaining the required results by the employment of iron mixtures of known quality for given purposes. Having once found by analysis the proportions of the constituents of any especially desirable iron, chemistry will enable the iron founder to reproduce these results at any time, and that without slavishly following rule of thumb mixes, made from fancy brands of iron bought at prices far exceeding their true value. Chemical analysis is therefore related to iron founding by true economy and sound business principles and no iron founder can any longer afford to ignore it.

Secondly.—Let us consider what is necessary for carrying out the chemical analysis generally required in an iron foundry.

First comes the selection of a suitable laboratory. This should consist of at least two rooms, one of which must be used exclusively as a balance room, for weighing up samples, etc., and calculating determinations; the second room for a general working room.

The chief considerations for a balance room are good light, freedom from vibrations and separation from the fumes of the working room. For the working room, good ventilation, light, and protection from the extremes of temperature are the chief points of consideration. A good water supply and drainage are also necessary and above all a good draft-cupboard for carrying off injurious fumes. The size of the rooms depends upon the work to be done, but if well lighted and ventilated they need not be large, and whenever it is possible they should be situated on the ground floor and not too close to the foundry.

The fitting up of a laboratory will also greatly depend upon the amount and character of the work required. For general foundry purposes when only the simple constituents of iron, coke, etc., are to be determined, the following list of articles might probably be found sufficient:

One short-arm analytical balance, weighing from 100 grams to 1-10 of a milligram.
One set of weights, 50 grams to 1 milligram.
One pair ordinary 1-lb. scales.
One set ordinary weights, 1 lb. to $\frac{1}{4}$ oz.
One 4-inch steel spatula.
One pair platinum tipped crucible tongs.
One 30-gram platinum crucible.
Three porcelain crucibles.
Three porcelain dishes.
Two Bunsen's burners.
One blast lamp.
One foot blower.
One water bath, with rings.
Six wide-mouthed bottles, with glass stoppers.
Six $\frac{1}{2}$ litre reagent bottles, with glass stoppers.
Three 1 litre reagent bottles, with glass stoppers.
One pipette, each 50 C C and 5 C C.
Half dozen assorted watch glasses.
One packet filter paper, each 7, 9 and 12 M M.
Six nests of beakers.
Three 250 C C conical flasks.

Three 500 C C conical flasks.
One Woulff bottle, 2 neck, 1 pint.
One Woulff bottle, 3 neck, 1 pint.
Three 50 C C burrettes.
One 1-litre boiling flask.
Two ½-litre boiling flasks.
Two ¼-litre boiling flasks.
Three glass funnels, each 2¾ and 4 inches.
One 100 C C graduated cylinder.
One 25-C C graduated cylinder.
One hydrometer and jar.
One 3-inch agate mortar.
One 6-inch Wedgwood mortar.
One 6-inch iron mortar.
Six pipe stem triangles.
Three burrette stands.
Two filter stands.
Two tripods.
One 360-degree thermometer.
One glass dessicator.
Two pounds assorted glass tubing.
Fifty feet assorted India rubber tubing.
Three dozen India rubber corks, assorted.
Half gross assorted corks.

The list of articles contains all the essentials for a small laboratory and would cost less than $200. The following list of reagents would be suitable for a laboratory fitted up as just described, and would, with proper care, be a sufficient supply for one year:

3 bottles of hydric chloride.
3 bottles of hydric nitrate.
3 bottles of hydric sulphate.
2 bottles of ammonium hydrate.
1 lb. acetic acid.
½ lb. molybdic acid.
¼ lb. chromic acid.

¼ lb. arsenous acid.
1 lb. bromisel.
1 lb. ammonium chloride.
2 lbs. ammonium nitrate.
½ lb. potassium nitrate.
1 lb. potassium per manganate.
1 lb. potassium chlorate.
¼ lb. lead acetate.
¼ lb. cadmium chloride.
1 lb. sodium hydrate.
¼ lb barrium chloride.
1 oz. phenal phtalein.
½ pint alcohol.
1 sheet each blue and red litmus paper.
20 gals. distilled water.

The cost of the foregoing reagents would not exceed $30. To these costs, however, must be added that of the carpenter's work, gas and water fittings, tables, hot plates, boiling closets, etc., etc., amounting to $30 or $40, so that the entire cost of a laboratory must be put down at from $250 to $300.

We will now turn to the practical part of the subject, and first let me call your attention to some most essential though preliminary details connected with chemical work, without a due observance of which, no determinations can be of any value. Foremost amongst these is the selection of the sample to be operated upon. This must be done with the greatest care and with strict impartiality; all choosing of the sample for special reasons must be scrupulously avoided. The sample should represent as near as possible the true character of the whole quantity from which it is selected. In the case of pig iron, which is seldom homogeneous, after selecting certain pigs their surfaces should be freed from extraneous matter and each pig drilled completely through from top to bottom, and the drillings thus obtained well mixed by grinding them together in an iron mortar till they are reduced to a uniform fineness. This is necessary not only for the purpose of thoroughly mixing them but also that they may be readily and uniformly acted upon by the dissolving agent. Special

attention must at all times be given to weighing and measuring quantities. Correct and expeditious weighing requires considerable skill and patience, also the possession of a really good analytical balance. Correct work cannot be obtained upon a poor balance.

The system of weights used in analytical chemistry is the metric, in which the gram is the standard and the smaller weight 10th, 100th and 1,000th of the gram.

Weighed quantities are generally expressed as so many grams or milligrams (i. e., 1,000th of a gram), and in practice it is not generally necessary to weigh samples closer than to 1-10 of a milligram.

In measuring fluids the metric system is also employed, measurements being generally expressed in cubic centimetres or litres, the litre being 1,000 cubic centimetres, a cubic centimetre of distilled water at its maximum density (39 degrees F. or 4 degrees C.), weighing exactly one gram. An easy and certain connection is thus established between weight and volume, which is of great service to the chemist. When employing volumetric methods extreme accuracy in measuring quantities is necessary, and the utmost care must be taken in reading the burrettes.

Besides the foregoing more general considerations there are a large number of a more special character, such as drying, dissolving, digesting, boiling, evaporating, filtering, washing, etc., strict attention to which is of the greatest importance in obtaining correct results. Many of them consume considerable time and require skill and patience in their execution. They cannot, however, be here treated of in detail, as to do so would far exceed the limits of this paper.

We will now proceed to illustrate by practical example some of the operations necessary for determining the common constituents of foundry iron. The methods to be illustrated are chosen from amongst many others on account of the short time required to conduct them, their simplicity in detail and operation and the known accuracy of their results.

PHOSPHORUS DETERMINATION.

Weigh out 2 grams of the sample and place in a 350 or 400 c. c. conical flask, add 75 c. c. 1.135 sp. gr. nitric acid, bring to a boil and when dissolved and still boiling add enough (about 15 c. c.) potassium permanganate solution (5 grams dissolved and diluted with water to 1000 c. c.) to produce a slight permanent precipitate, cool for about a minute and then dissolve precipitate by adding a little ground sugar and bringing to a boil. When solution is clear add 20 c. c. ammonium nitrate solution (800 grams dissolved and diluted to 1000 c. c.), cool to 80 or 85 degrees Centigrade and then add 50 c. c. ammonium molybdate solution (made to formula), cork flask and shake 5 minutes; precipitation will then be complete and the solution ready for filtering. Filter, wash 5 times with a 1 per cent solution of nitric acid and then 5 times with a 1 per cent solution of potassium nitrate, remove filter and paper from funnel and place in a beaker, seeing that all precipitate is out of flask, etc. Place the beaker under a burrette containing a standardized solution of sodium hydrate, 15.4 grams dissolved and diluted to 2000 c. c. in water (free from carbonate), and after carefully reading the burrette, run into beaker sufficient sodium solution to dissolve the precipitate and leave an excess of 3 or 4 c. c., and again carefully read the burrette; effect a complete solution of the precipitate by pulverizing the paper with a glass rod, then add about 250 c. c. water and 3 drops of the indicator ($\frac{1}{2}$ gram of phenalphthalien in 200 c. c. 95 per cent alcohol). Place beaker under a burrette containing a standardized solution of nitric acid (1 c.c. 1.42 sp. gr. nitric acid to 20 c. c. water), carefully read the burrette and then, drop by drop, stirring all the time, titurate till the last faint trace of pink color disappears, then carefully read the burrette.

Then the number of c. c. of sodium solution less the number of c. c. of acid solution equals the percentage of phosphorous expressed in 100ths of 1 per cent. This is the number of c. c. of sodium solution that appear as a remainder equals the percentage of phosphorous in the sample expressed in 100ths of 1 per cent.

Thus:

Na O H burrette initial reading (say)...	9.25 c. c.
Na O H burrette final reading.....	17.50 c. c.
	8.25 c. c.
H N O 3 burrette initial reading.....	12.30
H N O 3 burrette final reading.....	15.75
	3.45

Then 8.25
Less 3.45

. 4.80 percentage of phosphorous .048 of 1 per cent.

Note.—c. c. means cubic centimetre.

MANGANESE DETERMINATION.

Weigh out ½ gram of the sample into a 150 c. c. beaker then add 50 c. c., 1.20 spr. grs. nitric acid, and bring to a boil; when solution is complete add 10 c. c. boiling water, and then very cautiously add about 1 gram peroxide of lead and stir well three times; then add about another gram of peroxide of lead; stir as before, and add about 25 c. c. boiling water and again stir; then about 1 gram more lead salt and repeat stirring, then continue to add boiling water, about 25 c. c. at a time till beaker is full, stirring between each addition, and maintaining a full boil during the whole operation; let stand in a dark place till the lead salt has settled and the solution cooled; then decant as close as possible into a 300 c. c. beaker and add 50 to 100 c. c. cold water; place under a burrette containing a standardized solution of arsenious acid (4.95 grams arsenious acid, dissolved in 300 c. c. boiling water containing 15 grams sodium carbonate cooled and made up to 1,000 c. c.); read burrette carefully; titurate till the last trace of purple disappears; then carefully note the reading of the burrette.

Then the number of c. c. arsenious solution used, multiplied by 2 (½ gram having been taken), and the product multiplied by the factor found when standardizing the solution gives the percentage of manganese in the sample expressed in tenths of 1 per cent.

Example. Thus:

Initial reading of the burrette.....	7.55 c. c.
Final reading of the burrette.....	10.25 c. c.
	2.70
	2
The arsenous solution being only .8....	5.40
Strong factor was .8.....	8
	4.320

The percentage of manganese was therefore .432 of 1 per cent.

COMBINED CARBON DETERMINATION BY COLOR.

Weigh out and place in a test tube 6x$\frac{5}{8}$ 2-10 of a gram of the sample, and into a second and similar tube 2-10 of a gram of a suitable standard iron, the combined carbon of which has been exactly determined. To each of these add 5 c. c. of 1.20 spc. gr. nitric acid, and, as soon as the violent reaction has ceased, stand the tubes in a bath of boiling water and keep them boiling from 20 to 40 minutes according to the nature of the sample operated upon. When solution is complete let them cool in a dark place, and when cold carefully transfer the solution of the standard iron to one of a pair of matched reading tubes, filtering out any graphite present in a small filter and funnel held in the mouth of the reading tube. Wash carefully both the boiling tube and the filter, using as little water as possible, and then dilute the standard iron solution till it rises to a reading, which is exactly double its percentage of combined carbon. Place the finger tightly upon the mouth of the tube and reverse it; do this several times till the whole is well mixed. Then treat the solution of the sample of iron in the same manner, being extremely careful not to add so much water as to reduce the color below that of the standard solution. The color of the solution in these two tubes is then compared by placing them side by side and holding them up in such a manner that a clear and equal light may be transmitted through them. This enables the operator to observe the difference in color of the two solutions and to judge of the quantity of water required to dilute the solution of the sample to the color of the standard

solution. More water is then cautiously added, a little at a time, and comparison made after each addition until an even shade of color is obtained in both tubes. The hight of the solution in the tube containing the sample is then carefully read off, and this reading, divided by two (2), gives the percentage of combined carbon in the sample expressed in 1-10 of 1 per cent.

GRAPHITIC CARBON.

Treat one gram of pig iron with 30 c. c. dilute nitric acid, sp. gr., 1.13. When dissolved add 15 c. c. hot water. Heat to boiling. Filter through a paper that has been thoroughly treated with hot dilute nitric acid of 1.13 sp. gr.—washed with hot water—dried at 100 degrees c. and weighed. The filtration is conducted with the aid of the filter pump, the paper being supported in the funnel, by a perforated platinum cone. (The use of a Gooch crucible is a more desirable substitute for the paper and cone.) After being well washed with hot water, the paper and its contents are washed with a little alcohol—dried at 100 degrees c., to a constant weight, and the weight of the paper deducted. The paper and contents are placed in a platinum crucible and burned until the weight is constant—the weight of the crucible deducted, from this weight, and the remainder subtracted from the result obtained by deducting the weight of the filter paper. This gives the loss on ignition, which is considered to be Graphitic Carbon.

SILICON.

Weigh one gram of the pig iron, into a porcelain dish, add 30 c. c. dilute hydrochloric acid (acid 1, water 2), apply heat. When dissolved evaporate rapidly to dryness, reducing heat just before the mass becomes dry, to prevent spitting. Cool slightly, moisten the residue with hydrochloric acid, heat a few seconds, add 50 c. c. hot water—filter, using cone and filter pump, wash well with hot dilute hydrochloric acid, and then hot water—ignite and weigh. Fill the crucible, to within a third of its capacity, with a solution of potassium hydrate, of 1.20 sp. gr.—boil carefully for two minutes—filter—wash with hot water until no potassium hydrate

remains—burn off—weigh, and deduct from former weight, the remainder is considered Silica, which multiplied by .4666 gives Silicon.

SULPHUR.

The method suggested by Elliot is used for the estimation of Sulphur, and is too well known to require to be set forth here.

Five grams of the pig iron are used, being placed in a flask, dilute hydrochloric acid added, and the sulphur collected in a solution of potassium hydrate, of 1.20 sp. gr.—the solution is then acidulated, with hydrochloric acid, a few drops of starch solution added, and titurated (until the blue color becomes permanent) with a standardized solution of iodine.

The results of the analysis of the three specimens of iron being:

	Crane.	Bushong.	Thomas.
Graphitic Carbon	3.50	3.65	3.39
Combined Carbon	.00	.18	.00
Silicon	3.570	3.967	2.917
Manganese	.368	.736	.320
Sulphur	.011	.013	.011
Phosphorus	.874	.566	.678

From this analysis by the ordinary method of percentages, a mixture that should contain:

Graphite	3.475 per cent.
Comb Carbon	.036 per cent.
Silicon	3.323 per cent.
Manganese	.418 per cent.
Sulphur	.011 per cent.
Phosphorus	.714 per cent.

was then calculated upon the black board and was found to require

30 per cent of Crane Iron.
20 per cent of Bushong Iron.
50 per cent of Thomas Iron.

Mr. Outerbridge:—Gentlemen, I have been a very close observer of all that has been done, and I may say without any hesitation whatever that this has been without doubt a most remarkable exhibition of a bold undertaking to make a complete exhibit

of an entire analysis, not only of one iron but of three irons, and all on railroad time, without a moment of delay or any accident. Nobody who has ever manipulated an experiment before an audience fails to appreciate how difficult it is to do so without an accident or hitch of any kind. But to give so accurate an exhibition as this has been, with such certainty of results as any association of scientific people might feel proud of, seems marvelous. All of you, whether you have any knowledge or interest in chemistry or not, must have obtained some information of the general character of the work that is going on in progressive foundries to-day. Those of you who are experts must have learned the marvelous facilities which these gentlemen have shown; their ability to answer any question off-hand; the conclusion reached, even to the ten thousandth or one hundred thousandth of one per cent, and at railroad speed, is something that we should all feel proud of. I should like to propose a vote of thanks to Mr. James and his assistants who have come here and made all the preparations, and performed the manual work. I think a vote of thanks is in order for these gentlemen.

On motion of Mr. Outerbridge, a vote of thanks was extended to Mr. James and his assistants.

Mr. James:—Gentlemen, I appreciate the courtesy shown me and my assistants, and the vote of thanks of the assembly for the exhibition made. Some of the methods you have seen here to-day cost me some years of experiments, and also a period of severe sickness in the bargain. It has been a source of self-congratulation to myself to have been enabled to give you this demonstration, which, however, was attended with some few obstacles. We had to put in new piping and other accessories, so as to make the experiment. It is due to the Franklin Institute to say that they furnished us with all the apparatus and spared no trouble in helping us to fix up this place so that we might carry out the analysis. I thank you for your courtesies.

A souvenir in the shape of a miniature cast-iron saucepan, made from the irons analyzed, and cleaned with a sandblast apparatus, bearing the inscription: "First National Convention

of Foundrymen. Made by Thos. Devlin & Co., Phila., of irons analyzed at the Convention, Phila., Pa., May 13, 1896," was presented to the members of the convention with the compliments of Thos. Devlin & Co.

The Chairman then introduced Mr. J. H. Pepper, of the Iron Age, who read the paper contributed by Mr. D. J. Matlack, entitled

"HOW TO TURN OUT GOOD MOLDERS."

I have been asked to give my ideas on the subject "How to turn out good molders."

I cannot say that I have ever favored or practiced any fixed system which had this object in view, excepting to encourage good boys who showed intelligence, and were hardworking and painstaking. My actual experience has been confined to one foundry in which I have been successively, apprentice, journeyman and foreman, and any observations noted herein are produced from many years' participation in the business in those capacities. The foundry in which I have acquired my experience has, during all these years, been able to command a class of business of great variety and high character of requirements, and therefore apprentices and journeymen have had exceptional opportunities for advancement and improvement.

The art of "molding" is very ancient and many men have been engaged at it, all the good ones recognizing the fact that there was room for improvement, and that they individually could always learn something more about it. The best way to turn out good molders, I should think, would be to encourage the good, the intelligent and the industrious boys, and, after a fair trial, dismiss the incompetent and idle ones. Those of the latter class should seek fields where hard work and intelligence are not so largely required and seriously needed. Boys who are not fitted for the trade, but who are anxious to get along, should be advised and helped to secure a trade of a different character and more

in keeping with their peculiar fitness. Boys who are indifferent, idle and incompetent, should be dismissed, for the reason that the molding art requires, for successful attainment, the reverse characteristics. When a boy is not adapted to the trade for various reasons; when he is naturally incompetent, idle or vicious; or when he is not so inclined, but is kept at it by parents or guardians, and perhaps, if he had the chance, would adopt another calling, he should not be encouraged to continue an apprenticeship which could not result in any benefit to either himself or his employer. It is not always easy to make up one's mind to discharge boys who do not fit the business, and I will admit that I have not always practiced what I am preaching. But I am convinced that in all such cases I have erred by reason of mistaken kindness or unwillingness to possibly harm the boy, or disappoint his relatives or friends for whom I had a kindly and a closer feeling.

For the good of the trade and the business, as well as for the ultimate benefit to the boy, I believe that fitness, industry and intelligence only should be rigorously recognized. Intelligence and education are always great helps to boys in this as in any other calling, although our most intelligent and better educated boys generally develop into employers of some description. I have noticed that those apprentices who have developed into first-class molders have been successful mainly by reason of their own efforts, application and natural ability. It has been the rule in our shops that a boy should have the opportunity to so advance, and the same fact I suppose holds good in any other shop or trade. The best and most intelligent boys generally develop into something better than good molders. Some become proprietors of foundries, others become foremen, and there are still others who engage successfully in business of a different character. Sometimes they stick to the trade, but, as a rule, brains and education will not be confined to simply becoming a good molder.

I have always believed in affording opportunities to apprentices who have evinced a disposition to take advantage of them. Any

of our apprentices who are careful, painstaking, hardworking, and who also possess adaptation and inclination for the business cannot help finding the way, means, and opportunities necessary to make them good molders. If they remain with us after reaching their majority, the improvement is sure to go on for the reason that our business has always covered such a large variety of the highest character of castings. This must have been so, as shown by our men being in demand all over the United States, not only as journeymen, but also as foremen, and quite a number have engaged in business for themselves.

It is the rule with some establishments, including our own, that a portion of the wages of the apprentice shall be withheld and given to him in a lump sum at the expiration of his apprenticeship. This practice may be advantageous to both the boy and his employer in some ways, and I will not record myself as definitely either opposed to or in favor of the practice. I will only say that I cannot see that it operates to the advantage of the object to be gained—"turning out good molders;" for while it may have some slight effect in holding the good boy to the trade, it would also operate against the inclination of the employer to get rid of the incompetent boy, thus saving to himself the accumulated wages of which the boy will be deprived.

Any rule, practice or system inaugurated with a view of improving the grade of molders will to a large extent fail if the principles I have tried to explain are not given due consideration. Good apprentices will make good molders, and the larger the variety and higher the quality of opportunities given them, the better will be the results as to the ability of the molder turned out.

The meeting then, on motion, adjourned.

Immediately after adjournment the convention assembled on the steps of the Franklin Institute, where a photograph was taken.

The convention then, as guests of the Foundrymen's Association of Philadelphia, took lunch in the restaurant of the Master Builders' Exchange, opposite the Franklin Institute.

FOURTH SESSION.

FRANKLIN INSTITUTE,
PHILADELPHIA, Wednesday, May 13, 1896 (2 P. M.)

The session opened with a paper by Thos. D. West, entitled

"UTILITY AND ADVANCEMENT OF GREEN, DRY AND LOAM SAND MOLDING."

Mr. West:—Gentlemen, the paper which was allotted to me covers rather a broad subject, and I have not attempted to go over the whole ground, but rather to open the discussion of the subject of which the main element of the paper consists, in regard to the matter of the hardness of the mold for green sand work.

Mr. West read his paper, as follows, illustrating the same by sketches on the blackboard:

It is safe to say that 75 per cent. of all molders at the present day know little or nothing from experience of "dry sand" or "loam" work. For this reason there are comparatively few in the foundry business that know what elements decide whether certain castings are best or must be made in "dry sand" or "loam," in preference to "green sand." Our old school of apprenticeship largely taught the art of working in all three branches, and the "graduate of the sand heap" was not considered of much account as a molder unless he could work in any one of the three branches. Molders made after this plan could generally tell at a glance what method was the best for any piece of machinery work.

As a rule, the method that offered the greatest security for obtaining a good casting at the first trial, was invariably the plan adopted. As a "dry sand" or "loam" mold generally far exceeds a "green sand" mold as a sure means of obtaining a good casting, most all massive work was made by these methods; and before the advent of practical foundry literature, rarely were any very massive castings attempted in green sand, a fact which is to be largely charged to the general lack, among molders, of an understanding of the principles involved in the different manipulations necessary to make a good casting. This may seem a strange statement to many at the present day.

When the old school of molders far exceeded those of the present time in being all-around skilled men, able to work in any branch of founding, it is to be said that their knowledge was gained by sad experience, and practice was largely imitative. It was very rare to find a molder who could define the principles involved in any work he might be doing. If he "weighed a cope," he did so by guess work, and if it "ran out" the first time, he simply put on more weight at the second casting, and if this met the same fate, the conclusion was often drawn that it was best to make a "bolting-down floor," which he felt Satan himself with all his eruptions could not raise. It rarely occurred to the molder of fifteen to twenty years ago that "weighing a cope" involved the question of static head pressure and was simply a problem of physics and figures. This, it may be said, is one of the advances due to practical literature.

As imitative skill has given way to scientific knowledge, or a true understanding of the principles involved in the art of founding, just so fast have improvements been made in methods of molding. As illustrating the changes brought about by this agency, some shops are now making massive castings in green sand that a few years back would not have been thought possible of achievement, except by loam or dry sand methods of molding. It was generally supposed that the more massive the casting, the harder was it necessary to make the "bed" or face of the mold composing its lower body; and on account of this belief, whenever anything very massive was attempted in green sand, the metal often went to the roof of the shop before the mold was half filled.

Briefly stated, success in making massive castings in green sand is due to recognizing the necessity of having the face of a mold no harder for the casting of a massive body than for one of small weight, head pressure being considered equal in each case; and for strength to resist the extra strain that might be due to head pressure of liquid metal, looking to the "backing" or foundation under and around the sides of the mold. To insure a solid "backing," it is best, as a general thing, that all massive castings be "bedded" in the floor, for then if the floor is a dry one, as it should be, and the outer body of the mold is well rammed and protected

to resist the strains of head pressure, the danger of "burst-outs" and "blow-ups," as compared with cases in which the bottom portion of heavy castings are "rolled over" or molded in a "nowel," is very materially lessened. It is true many large castings in being molded are "rolled over" and successfully made by such plans; but these are not to be classed as massive work, more often coming under the head of big nothings, when floor or shop room occupied is compared to the weight obtained.

A good plan which the writer has adopted with massive castings made in green sand, is to form all pouring gates with dry sand cores. As it is through the "gates" that the wash and rush of the hot, seething metal can work the greatest injury and start a mold blowing, the wisdom of using cores for forming pouring gates, instead of all green sand, will be very evident. Cores have also been placed at any dangerous corners or flanges that might exist near the gates or in any other portion where it was feared "blowing" might be started from the "vent" not being freely liberated, if such portions were formed of all green sand. Then, again, there are massive castings having projections or portions which may extend deeply from the main body of the casting, that it is often well to form by cores, dry sand or loam sections to lessen the risk of bad work in a casting whose main body might be safely made in all green sand.

Another method now employed by many is to "skin-dry" a green sand mold. This method calls for a grade of "facing sand" possessing a loamy nature, that when coated by wet blacking, the same as generally used to "black" a dry sand mold, and dried by heat, will bake to a firm crust and not go to a dust if the skin of the mold is in the least broken. It requires some experience to attempt "skin-drying," and even good molders, having never done such work, should start with castings on which the loss could not be a heavy one.

Another factor in connection with the making of massive castings in green sand by means of "bedding-in," and often employed for "skin-drying" as well as with raw green sand work, is the preparation of floors. Some shops have a practice of simply throwing in a few pails of water in the hole left by the hot casting

and then filling it up with ill-mixed sand, loosely tramped. I have often seen very heavy losses, with danger to life, by such a practice. Castings molded near such holes, on pouring have burst out into the ill-filled hole, the resistance being insufficient to withstand the head pressure exerted against the lower body of the sides comprising the mold which was being cast. Whenever a casting is being taken out of the floor and is not to be made at once in the same hole, all dry and loose sand should be shoveled out. After it has been fairly mixed on the floor, it should be shoveled back in layers about six inches deep and rammed down solid with butt-rammers until the hole is thus well rammed up to the level of the general floor. Such a practice is sure to pay in the end and make it possible to cast daily, massive work in green sand that could not be otherwise attempted in many shops of to-day.

It is the general opinion that the green sand method of molding is in all cases, wherever it can be employed, the most economical. Many err in this conception of founding. As a rule, it requires greater skill and care to produce a large perfect casting in green sand than by dry sand or loam work. By reason of the less risk attached to "dry sand," some shops making duplicate work, have, on account of the difficulty in obtaining skilled green-sand molders, devised riggings to make certain jobs in dry sand. By this means poor tools of molders, or the more intelligent laborers, could be used to turn out good castings; and often such methods materially lessen the cost of production. Many changes have of late years been brought about in shop methods by utilizing "dry sand" to make duplicate castings, where shops have specialties, or very much of a certain line of work to do.

While loam molding has not advanced to any noticeable degree, still, through a better understanding of the principles involved in molding, and specialty shops making their own loam molders, less difficulty is experienced to-day with loam work than existed ten to fifteen years ago. But in a jobbing way, the general heavy-work founder is worse off to-day than ever, in ability to secure all-around loam molders to turn out creditable work at the first casting.

On general principles, loam molding is the most expensive method that can be adopted, and the less a founder has to do with such work at prevailing prices the less money will he lose. As a rule, loam work is only employed to make large or massive castings that, owing to their great vertical extent or intricate form, could not be made in green sand; and again, the fact that loam molding does not demand complete patterns, often causes whole castings or parts of castings to be made by this method.

In closing this paper, a word should be said as to light work founding. The advance made in this line is worthy of comment. That methods of light founding now far excel those of a few years back, is to be credited largely to the able management of bright minds laboring to rival competitors. To whatever degree methods in casting may have advanced, no greater achievement has been made than the "casting" of ballots to further the unity of founders as exemplified by this national assembly. May organization among foundrymen reach far and wide until all feel its influence, and this great industry makes the advance which general discussion and the diffusion of the best methods are calculated to secure.

The Chairman:—You all have the paper of Mr. West, I presume, and by glancing through it you can take up such divisions of the paper as you may deem worthy of discussion.

Mr. Frank:—It occurs to me that the plan proposed by Mr. West would be well enough on plain surfaces, but when you come to do the work to be bedded in, it cannot be relied upon, and the judgment and skill of the molder cannot be regulated so well. The skill of the molder must be brought into play; there is where the molder exercises his greatest skill. In casting work, say from one to thirty tons, we have experienced a great deal of trouble of this kind.

Mr. West:—I think Mr. Frank misunderstood the idea in reference to the sketch there; it merely relates to the making of anything that would have a flat surface. I would state that the subject is a very broad one; it could not be covered in a short paper. I have endeavored to state principles which upon the study of

the paper may be found of value to you. I didn't look for any great discussion on the subject.

The Chairman:—I suppose the paper has been in the hands of the gentlemen so short a time that they have not been able to digest it fully.

Mr. West:—On this question of bedding in there is a chance for a great deal of improvement. Many shops will do work over, when, if they can be educated up to a proper system of bedding in, better results will be obtained than by rolling the work over.

Mr. Prince:—We do quite a lot of bedding in, in the line Mr. West has spoken of, plates running from 7 to 8 feet long by 4 or 5 feet wide would almost invariably be bedded in. We find it much more expeditious than to attempt to roll them over.

Mr. Wathey:—I have done some work of that kind. I have never attempted to make a large boiler front by rolling it over. I have made some of the largest fronts, and I don't think I would ever try to roll them over if I could get a good sand. I would prefer bedding in.

Mr. Knoeppel:—I have had experience in bedding in. I follow out the instructions given, with the exception of heavy pieces and also in boiler fronts, where I work in the sand. In that case we use the bedding in with all large surfaces, where I would have large openings so we could get our sand in. In the majority of cases it pays the foundryman to bed in. Sometimes we have pieces that are 8 or 10 feet square, and you know a flask would be an expensive thing in making up a piece of that character. I find the majority of molders have a tendency to clamp their flask on the board proper. I find the better way is to use a heavy batten, 6 inches square, and clamp the flask on the batten direct instead of clamping it on the board; in that way you have a thorough foundation from one end of the casting to the other. On the whole, I think the idea expressed by Mr. West, on the blackboard, is the only proper guide for thorough bedding.

Mr. Weyhenmeyer:—My experience in green sand molding is quite extensive, and especially in bedding in. The design on the blackboard carries out my idea exactly. In bedding in large fire

fronts or anything that has a wide surface of iron to run over, it is necessary to make the pattern as much as possible open on the top, so there is very little place for ramming horizontally. The mold can be made sufficiently hard by vertical hammering. In the neck of the elbow you get a very dangerous point. I would insist upon having that elbow bedded in. If there is any danger with the mold, then skin-dry it. In talking about skin-drying, I have had a good bit of experience in that line. In order to dry the mold properly and quickly, sufficient time must be taken to make the mold right. By making your mold of sand that is as pliable as you can get it, you must have sand that is mixed with sharp sand. In our district we make a great many heavy castings; we make castings up as high as five or six tons, for pumps. I never allow my men to use a trowel for blacking; the blacking is all done with a camel-hair brush. Some of you have seen cases where a molder will swab a mold all over with a big brush, which causes much difficulty in getting it off. You don't need to go to that trouble if you use a camel-hair brush, and besides it will be so much more readily put on, and more uniform. I have had some experience in that. I never saw it done until I did it myself. It is a feature which would help the foundry business wonderfully, because we are in an age when we are obliged to use more brains than formerly. It is much harder to be a founder to-day than it was ten years ago. The questions that now arise in the minds of manufacturers did not come up ten or fifteen years ago. But it is different to-day. If all these founders here will give their views in the matter it will be of interest to us all. The green sand molder is the molder of to-day. Give me a green sand molder, and I know that I have something. The highest wages we pay are to the green sand molder, who will turn out his work without having nine-tenths of it go to the scrap heap; and we expect this man to bed in instead of using the rolling-over method. You must see that the man who does the job does it properly.

Mr. Frank:—What is your mixture of sand?

Mr. Weyhenmeyer:—You must make it of the proper consistency. We get a sand that is equal, in my estimation, to any sand that comes out of Pennsylvania. I can do as well with it as

with any sand that I ever had; I can run more risks and get better work. We always want what we call "Lumberton" sand. We want a heavy sand with a body to it; then we mix it with a sharp sand. We have a mountain loam, which we mix with the sand, in the proportion of 1 to 3 or 1 to 2, as our judgment may dictate. You skin-dry a mold in order to insure quality in the thickness of the casting, and preserve the corners without straining in the lower parts, and if you get it skin-dried it don't make any difference to you what the mixture is, only so you can let the gas free in the lower section of your casting. I am from Pennsylvania. We have men here from away out on the Pacific Slope and from Canada, and I cannot give you a formula for mixing sand that would be applicable to all these localities. But I believe we can educate each other in the manipulations of the facilities we do possess. Of course, some have better facilities than others.

Mr. W. J. Keep, of Detroit, then presented a paper on "Physical Tests and the Chemical Strength of Cast Iron," copies of which had been previously distributed through the meeting.

The paper was as follows:

"PHYSICAL TESTS AND CHEMISTRY OF CAST IRON."

The physical properties of cast iron are shrinkage, strength, deflection, set, chill, grain and hardness.

Physical tests determine to what extent castings possess these properties.

Tensile tests should not be used for cast iron, but should be confined to steel and other ductile materials.

TABLE I.—TENSILE STRENGTH PER SQUARE INCH.

Iron.	Size of Test Bar .375 Sq. In.	Size of Test Bar 1.128 Sq. In.	Average Per Cent. Silicon.
Iroquois Series, 1	20,000	15,700	.80
" " 2	20,580	22,500	1.21
" " 3	25,050	20,450	1.88
" " 4	21,850	19,350	2.01
" " 5	22,425	19,750	3.19
" " 6	25,550	17,200	3.04
Southern Series, 14	14,000	21,300	2.81
" " 13	23,525	20,500	3.18
" " 15	24,400	20,300	3.50

Compression Test.—Cast iron is employed to resist crushing loads when used in the shape of columns, pedestals and the like, and for this reason this test, using long pieces, should be made, but is generally neglected, from the common erroneous impression that the resistance of a small cube or cylinder, which is enormous, is always in excess of loads which can be applied.

Transverse Test.—As cast iron is commonly used to resist cross breaking, this is the most frequent test to which it is subjected. The ease with which a transverse test can be made is one reason for its general use. Table II. gives the transverse strength of different sizes of test bars, from several different mixtures of iron.

Strength of Cast Iron.—Specifications for castings state the strength required of a test bar which shall be cast from the same iron that is poured into the casting. The strength of the casting it then calculated by the formula $W_1 = \frac{W b_1 h_1^2 l}{b h^2 l_1}$ To ascertain whether this formula gives the correct strength of the casting, I have introduced the following tables:

CHART I.

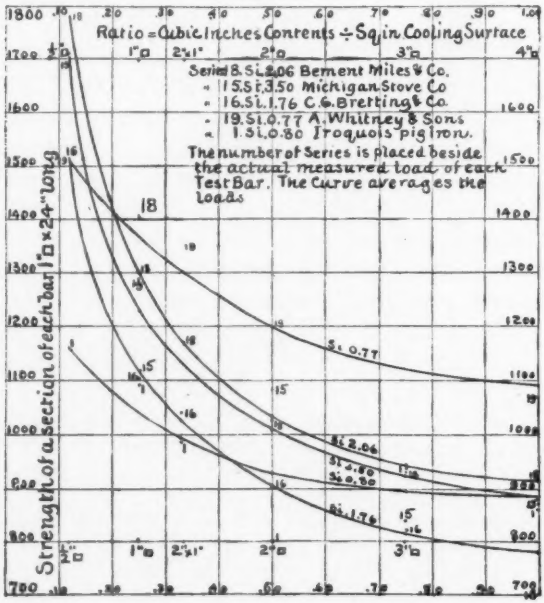

Ratio = Cubic Inches Contents ÷ Sq. in Cooling Surface
Series 8. Si. 2.06 Bement Miles & Co.
" 15.5 Si. 3.50 Michigan Stove Co.
" 16.5 Si. 1.76 C. C. Bretting & Co.
" 19. Si. 0.77 A. Whitney & Sons
" 1. Si. 0.80 Iroquois pig iron.
The number of Series is placed beside the actual measured load of each Test Bar. The Curve averages the loads
Strength of a Section of each Bar 1"□ x 24" long
1"□
2"×1"
2"□
3"□
Si. 0.77
Si. 2.06
Si. 3.50
Si. 0.80
Si. 1.76

TABLE II.—TRANSVERSE STRENGTH OF CAST IRON.

Foundries.	Southern	Iroquois.	No. Series.	½" Sq. x 12"	1" Sq. x 12"	1" Sq. x 24"	1" Sq. x 48"	1" Sq. x 54"	1" x 2" x 12"	1" x 2" x 24"	2" Sq. x 24"	3" Sq. x 24"	4" Sq. x 24"
16	14	1	1	289	2,580	1,013	513	468	4,181	1,857	6,400	25,200	54,500
18	13	2	2	339	2,140	1,023	550	471	4,050	1,958	7,050	22,800	50,450
19	15	3	3	389	2,619	1,248	.....	518	4,300	2,290	7,150	19,350	42,700
		4	4	427	2,620	1,107	556	517	4,335	1,832	7,025	19,300	48,750
		5	5	430	.....	1,232	585	540	.....	2,077	8,100	23,175	42,600
		6	6	471	2,214	.....	557	425	4,180	.....	6,225	17,750	42,150
378	378	289	Average Silicon.	0.80	1.21	1.88	2.01	3.19	3.04				
446	494	339		1.21	1.88	2.01	3.19	3.04					
377	427	389		1.88	2.01	3.19	3.04						
		427		2.01	3.19	3.04							
		430		3.19	3.04								
		471		3.04									
1.76	2.82												
2.06	3.18												
0.77	3.50												
378	2,591	1,200	612	512	4,765	1,962	8,275	25,250	52,450				
446	.....	1,400	.....	.....	.....	2,200	8,450	24,050	55,050				
377	.....	1,292	.....	.....	.....	.....	8,650	22,700	56,350				
	427	1,117	..	.....	.....	.....	.....	.....	.....				
	.....	.....	.....	.....	.....	.....	.....	.....	.....				
	.....	.....	.....	.....	.....	.....	.....	.....	.....				
1,104	.....	.....	.....	.....	.....	.....	.....	.....	.....	2,079	7,250	22,150	44,500
1,400	.....	.....	.....	.....	.....	.....	.....	.....	.....	2,352	8,200	25,350	58,700
1,292	.....	.....	.....	.....	.....	.....	.....	.....	.....	2,703	9,600	31,600	68,500

TABLE III.

Strength of a Section 1" sq. x 24" long, found by Formula from Table II.

Original Test Bars.	½" Sq. x 12"	1" Sq. x 24"	2" x 1" x 24"	2" Sq. x 24"	3" Sq. x 24"	4" Sq. x 24"
Series 19.....	1,508	1,292	1,351	1,200	1,170	1,070
" 18.....	1,785	1,400	1,176	1,025	938	917
" 15.....	1,708	1,117	.....	1,081	840	880
" 16.....	1,512	1,104	1,039	906	820	695
" 1.....	1,156	1,096	986	800	933	851

TABLE IV.

Readings from the Curves in Chart I, Averages of Table III.

Original Test Bars.	½" Sq. x 12"	1" Sq. x 24"	2" x 1" x 24"	3" Sq. x 24"	3" Sq. x 24"	4" Sq. x 24"
Series 19.....	1,508	1,365	1,300	1,200	1,120	1,087
" 18.....	1,784	1,300	1,170	1,030	942	955
" 15.....	1,708	1,230	1,130	1,008	920	885
" 16.....	1,512	1,115	1,022	904	812	780
" 1.....	1,156	1,038	990	928	895	885

TABLE V.

Size of Test Bars.	½" Sq. x 12"	1" Sq. x 24"	2" x 1" x 24"	2" Sq x 24"	3" Sq. x 24"	4" Sq. x 24"
Series 19, Calculated	341	1,365	2,730	10,920	36,855	87,360
" 19, Actual....	377	1,365	2,600	9,600	30,240	69,568
Series 18, Calculated	325	1,300	2,600	10,400	35,100	83,200
" 18, Actual....	446	1,300	2,340	8,240	25,434	58,560
Series 15, Calculated	307	1,230	2,460	9,840	33,210	78,720
" 15, Actual....	427	1,230	2,260	8,064	24,840	56,640
Series 16, Calculated	279	1,115	2,230	8,920	30,105	71,360
" 16, Actual....	378	1,115	2,044	7,232	21,924	49,920
Series 1, Calculated	259	1,038	2,076	8,304	28,026	66,432
" 1, Actual....	289	1,038	1,980	7,424	24,165	56,640

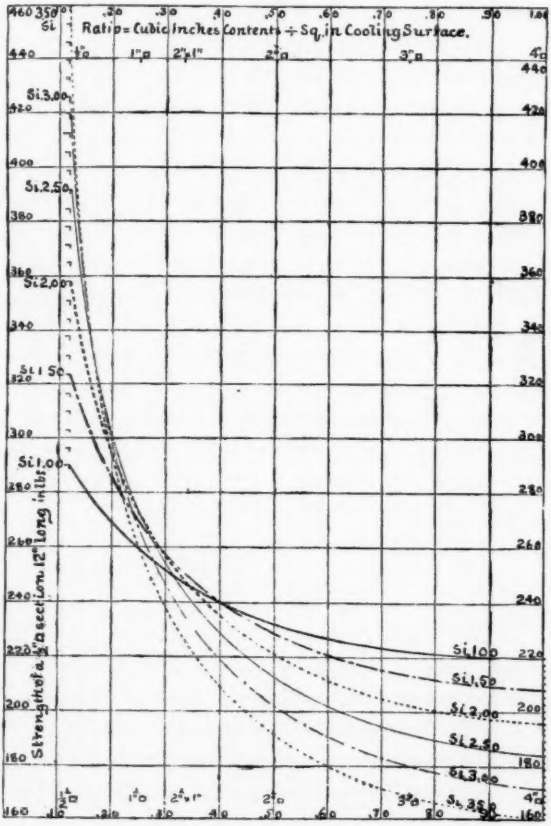
Table V. gives the strength of full-sized bars. The upper rows of figures are found by applying the formula to the strengths in the column headed 1" sq. x 24" of Table IV., and the lower figures are found by applying the formula to each corresponding strength in Table IV. (The 1" and 2" x 1" strength of Series 1 are aver-

ages of all bars of those sizes in Table II.) The irregularities of strengths in Tables II. and III. are caused by conditions attending cooling.

Chart 1 and Table IV. show the strengths of the same bars unaffected by such conditions.

In Table II., Series 1 to 6 give the strengths of different sizes of test bars made from the same pig iron, with the silicon varying from 1.00 to 3.50 per cent. Chart II. shows the plotted strength of a section of these test bars $\frac{1}{2}$" sq. x 12" long, corrected so as to make regular curves.

CHART II.



Having the measured strength of a test bar ½ in. sq. x 12 in. long, the formula would make all larger test bars from the same iron of the same proportionate strength; in other words, a ½ in. sq. section of each size would have the same strength. Chart II, however, shows that in every case a 1-2 in. sq. section of a test bar which was cast larger than 1-2 in. sq. is weaker, and that the weakest 1-2 in. section is that taken from the largest test bar. The strength decreases as the size of the casting increases. The actual strength of a small bar substituted in the formula will indicate too great strength in a large casting, and if the actual strength of a large test bar be substituted the calculated strength of a smaller casting will be too small. The calculated strength must be corrected to correspond with the strengths shown by Chart II. For example, if the strength of a 1-2 in. sq. test bar 12 in. long is 288 lbs., and it is required to find the actual strength of a test bar 2 in. sq. and 24 in. long, follow the curve which begins at 288 to the perpendicular of the 2 in. sq. bar, and we find that the strength of a 1-2 in. sq. section of a 2 in. sq. bar is 232. Applying the formula to this last number, we find that the actual strength would be 7,424 lbs., while if applied to 288 it would have been 8,304 lbs., or 880 lbs. stronger than the casting would actually be. Every different size of casting poured from the same iron will have a different proportionate strength, and the largest casting will always be proportionately weakest. The reason for this is that the slower cooling of the larger casting produces a coarser grain. By measuring the strength of a 1-2 in. sq. test bar, and by using Chart II, the approximate strength of any size of casting may be determined. The preceding tables and charts show that a 1-2 in. sq. test bar grows stronger as silicon is increased, because silicon prevents brittleness. They also show that a large casting grows weaker with each addition of silicon, because slow cooling enlarges the grain more rapidly when there is more silicon. The lower the silicon the weaker the small castings and the stronger the larger castings, and the higher the silicon (up to 3 per cent) the stronger the small castings and the

weaker the larger castings. Strength is simply a question of grain. Chart I shows that by a careful selection of pig iron and scrap having the closest grain, the greatest strength may be obtained for large castings. The closer the grain without brittleness the greater the strength. The strength of the 4 in. sq. test bar in Series 1 with 1.00 per cent silicon and in Series 15 with 3.50 per cent silicon is the same. By careful selection of pig irons, as in Series 18, both small and large castings from the same iron can be made strong, because silicon is high enough to prevent the small castings being brittle, and the grain was so close as to give great strength to the larger castings.

Referring again to Chart II, the variation in the strength from variation of silicon, and in the rate of cooling, causes each strength curve to cross all other curves, and such crossing is in the region of the test bars 1 in. sq. and 2 in. x 1 in. Test bars of these dimensions do not give as large a variation of strength as test bars either smaller or larger, and they give the same record for more than 1 percentage of silicon. The 1-2 in. sq. bar shows the largest variation of strength, and in any one mixture its strength generally increases as silicon increases. The 4 in. sq. test bar gives a definite record of the variation of strength on account of the variations of silicon, but its record is exactly the reverse of that of the 1-2 in. sq. bar. If the record of these two sizes of test bars are joined by a curve, it will give the approximate strength of all intermediate sizes of test bars, poured from the same iron, or if we know the percentage of silicon, and have the strength of a 1-2 in. sq. test bar, we may draw the curve belonging to that percentage of silicon, beginning at the strength of the 1-2 in. sq. bar, and thus find the approximate strength of a test bar 4 in. sq. and of intermediate sizes.

Shrinkage of Cast Iron.—Table VI contains the measured shrinkages of each of the test bars in the Series 1 to 6, with silicon varying from 1.00 to 3.50 per cent, and Chart III shows these shrinkages plotted and corrected to make regular curves.

CHART III.

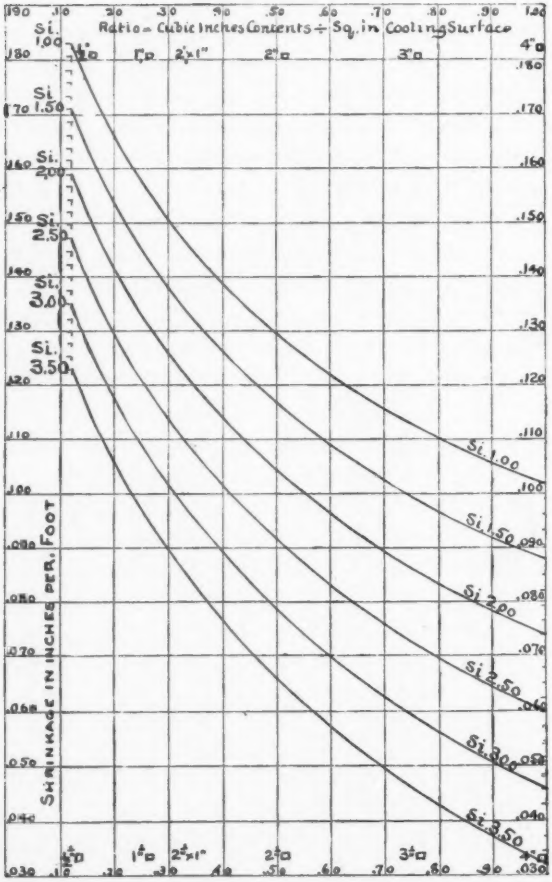

Ratio = Cubic Inches Contents ÷ Sq. in Cooling Surface
Si. 1.00
Si 1.50
Si. 2.00
Si. 2.50
Si. 3.00
Si. 3.50
SHRINKAGE IN INCHES PER FOOT

TABLE VI.—SHRINKAGE PER FOOT.

Size of Test Bars.	½" Sq. x 12"	1 Sq."	2"x 1"	2" Sq.	3" Sq.	4"Sq.	Av. Si.
Series 1.....	.183	.160	.148	.131	.116	.102	0.80
" 2.....	.172	.150	.138	.125	.110	.106	1.21
" 3.....	.165	.145	.130	.109	.069	.039	1.88
" 4.....	.162	.143	.123	.099	.066	.128	2.01
" 5.....	.157	.105	.094	.075	.067	.057	3.19
" 6.....	.161	.130	.086	.077	.085	.033	3.04
Series 19.....	.238	.153	.142	.144	.126	.115	0.77
" 18.....	.161	.139	.120	.091	.067	.042	2.06
" 15.....	.123	.098	.083	.072	.063	.035	3.50
" 16.....	.171	.151	.143	.129	.100	.069	1.76

Table VI and Chart III show that shrinkage varies in the same proportion that silicon varies. Shrinkage is a measure of the influence of silicon, and is therefore a mechanical analysis. Fortunately, this is a very simple and expeditious way to find the approximate percentage of silicon in a casting. It is the influence of silicon that a founder wishes to measure, and not the actual percentage. In any one mixture of iron an increase of shrinkage shows a decrease of silicon, and vice versa. Having from experience found which shrinkage accompanies the best castings for a given purpose, there is never an exception to the rule that a greater shrinkage than that which has been found desirable shows that more silicon is needed, and vice versa. A shrinkage of .160 in. per foot in a 1-2 in. sq. test bar may indicate iron suitable for the best machinery castings, or .125 in. for the best stove plate. Shrinkage measures the influence of silicon under all of the conditions existing in the foundry. Silicon can be varied with the greatest facility, and is therefore used to control a foundry dry mixture and keep its quality uniform. If a new brand of iron is added to the mixture, the shrinkage tells at once whether it contains more or less silicon than the average in the mixture, and whether it is an economical iron to use. Having the shrinkage of a 1-2 in. sq. test bar, refer to the Shrinkage Chart III to find the approximate percentage of silicon in the iron, and this will tell which curve of Chart II to use with the strength of the same 1-2

in. sq. bar, to find the strength of any other size of casting poured from this same iron.

Deflection of Cast Iron.—If the same size of test bar is used for all tests, the deflection of the bar indicates approximately the character of grain. Great deflection shows that the iron is soft and that it has an open grain.

Set.—After a test bar has been bent by a test load, and the load has been removed, the bar will spring back, but will not fully regain its original form. The amount that it remains bent is the set, and it gives the same information as a measure of deflection.

Chill.—The depth of chill that can be given to a test bar is measured by making the mold at the end of the test bar of cast iron. This absorbs the heat so rapidly that the iron sets immediately it touches the chill. The thickness of this instantaneous solidification is the depth of chill. The chilling property of cast iron is imparted in the furnace, and is probably due to some tendency of carbon and silicon to combine under peculiar conditions. Generally the more silicon the less the chill, but the simple presence or absence of silicon will not account for the phenomenon of chilling. To get a good chill, irons must be used which chill naturally.

Spongy Spots or Cavities.—The founder usually calls these spots shrink holes, and it is quite common for him to call the settling of the iron in the gate shrinkage. The loss of heat will probably account for a part of this. In large castings this settling of the fluid iron is supplied by feeding more hot metal. To allow this metal to reach the part which shall become solid last, a communication is kept open by churning with an iron rod. The shape of a casting as well as the size determine these so-called shrink holes. Cast iron expands after it has become solid, not at the time of the solidification of each crystal, but after a rigid shell is formed. This expansion continues for some time. If a casting is so shaped that some portion is partially fluid while this expansion of the shell of the casting is taking place, there will not be enough metal to fill the interior, and a cavity is the result. These spongy holes are not therefore produced by shrinkage, but by the expansion of the shell of a casting. Low silicon iron expands less

and sets more quickly than that which contains more silicon. (See Trans. Am. Soc. Mech. Eng., Vol. XIV, p. 1125), and it has been found that for large castings such low silicon iron will need much less feeding, and will contain less spongy spots than iron which contains a large percentage and which remains perfectly fluid at the center until the last crystal has formed. It may be too soon to propose the name of "expansion holes" for these spongy spots, but the time is not far off when the term shrinkage will be restricted to the external contraction produced by loss of heat, and which the patternmaker provides for with his shrink rule.

Chemical Composition and Physical Quality.—There have been very few records which would allow a direct comparison between the physical and chemical properties of cast iron. The complete records of the Committee on Tests and Methods of Testing, of the American Society of Mechanical Engineers, will be published during the present month, and the tables given in this paper are taken from those records. The tests are the most complete and extensive that have ever been made. The committee at the outset associated with themselves the eminent chemists, Messrs. Dickman & Mackenzie, of Cleveland and Chicago, who have made full analyses of all test bars and of all materials used. Professors R. C. Carpenter and C. E. Houghton, of Cornell University; Prof. C. H. Benjamin, of Case School of Applied Science, and Prof. I. H. Woolson, of Columbia College School of Mines, have tested all of the bars, except those 1-2 in. sq., which were tested with Keep's Autographic Testing Machine. We are now able to compare the most accurate chemical determinations with the best physical tests.

Before beginning this work, the Iroquois Furnace Co., and the Ashland Iron and Steel Co. (Wis.), each sent three tons of carefully-selected pig iron, and one ton of Ohio iron was procured containing 10 per cent of silicon. Each of these irons was furnished with a guaranteed analysis, and each pig was broken into small pieces to insure a uniform grain. After the iron was received, drillings from twenty-five pigs of each of the three irons were analyzed. The proportions of the irons needed to make silicon vary in half per cent intervals from 1.00 to 3.50 per cent, were

calculated, and each iron was carefully weighed and packed in labeled boxes with the coke for melting. This iron was mixed according to the most careful chemical analysis. To make the investigation cover regular foundry practice, four founders made test bars from their regular mixtures. The Michigan Stove Co. made Series 15 from all Southern iron. C. G. Bretting & Co. Ashland, Wis., used "Hinkle" charcoal pig iron and scrap for Series 16. Messrs. Bement, Miles & Co., of Philadelphia, made Series 18 from their best mixture for heavy machine castings, and Messrs. A. Whitney & Son, of Philadelphia, made Series 19 from their regular car-wheel mixture.

TABLE VII.

	Series.	Nominal Silicon.	Per Cent. of Silicon.						Silicon Av.
			½"Sq.	1"Sq.	2"x 1"	2"Sq.	3"Sq.	4"Sq.	
		p. c.							
Iroquois	1	1.00	.83	.79	.78	.82	.72	.88	.81
	2	1.50	1.09	1.14	1.70	1.33	1.10	.88	1.20
	3	2.00	1.73	1.73	1.70	1.50	2.17	2.50	1.88
	4	2.50	2.13	1.69	1.60	1.80	2.17	2.07	2.01
	5	3.00	2.42	2.65	2.40	3.36	3.67	4.67	3.19
	6	3.50	2.74	2.69	2.70	2.62	4.30	3.22	3.04
Southern	15	....	3.29	3.50	3.52	3.48	3.75	3.42	3.51
C. G. Bretting & Co	16	....	1.90	1.86	1.68	1.61	1.83	1.70	1.76
Bement, Miles & Co	18	....	2.29	2.09	2.24	1.82	2.06	1.88	2.06
A. Whitney & Sons	19	....	.87	.72	.78	.81	.68	.73	.77

Silicon and Physical Quality.—A comparison of tables VI and VII shows a very close correspondence between the percentage of silicon and the shrinkage of any one size of test bar, but while the silicon is supposed to be uniform in all the sizes of test bars poured from the same iron, the slower cooling of the larger bars has decreased their shrinkage.

The variation in shrinkage is much more regular than the variation in silicon, which shows that shrinkage measures the whole casting, while a chemical analysis measures a few drillings taken

from one spot. If an analysis of silicon in the pig iron would indicate what the silicon would be in the casting, it would allow a guess to be made as to the physical quality of a casting, but the actual quality must be found by a physical test. For example, Series 1 and 19 contain the same silicon, and yet the physical quality of the castings are entirely different. The amount of silicon in Series 16 and in Series 18 does not give the slightest hint that 18 will be strong and that 16 is weak. The difference is wholly physical from beginning to end. Scrap is broken and graded according to fracture into different piles, but each piece of scrap was made in a different foundry, from a different iron mixture, and would show a different chemical analysis. There can therefore be no such thing as grading scrap by chemical analysis. The grading is purely physical, and the grading of pig iron is much the same. A soft, close-grained pig iron (or scrap)

TABLE VIII.—SIZE OF TEST BAR ½" SQ. X 12" LONG.

Total Carbon.	Silicon.	Shrinkage	Strength.	Deflection	Chill.
3.24	2.87	.131	.485	.20	.09
.....	2.31	.162	.403	.22	.07
.....	2.17	.180	.415	.22	.05
....	3.37	.126	.478	.21	.07
... .	3.31	.132	.425	.21	.02
.....	3.19	.146	.430	.22	.03
.....	3.13	.141	.436	.21	.03
... .	3.06	.150	.344	.....	.03
.....	2.89	.153	.435	.21	.02
.....	3.04	.166	.402	.22	.04
3.08	2.85	.172	.413	.21	.04

will generally make a soft and strong casting, irrespective of its chemical analysis. Increase of silicon in any individual mixture (to 3.00 per cent) increases the strength of small test bars, but decreases the strength of large test bars. Iron deficient in silicon is brittle and weak, but when too much silicon is added, the iron again becomes brittle and weak. The slight variations of silicon shown in the table, in any one series, do not conform to the varia-

tion in strength at all. Strength is entirely a matter of grain, and the reason for the variation of strength with silicon is that silicon influences the size of grain. The only way to determine strength is by a physical test, corrected by Chart II.

Silicon never behaves the same in different iron mixtures. One pig iron, that is open-grained, will make as soft castings with 1.50 per cent of silicon as another pig iron with 2.00 per cent of silicon, and the strength can be made the same in each case.

The same shrinkage always shows the same influence of silicon, but for the reasons just mentioned the shrinkage of a one-half inch test bar may be .160 in. for 1.50 per cent of silicon in one case and for 2.00 per cent in another case.

The percentage of silicon, as found from the shrinkage of the castings by Chart III, is only approximate, but the shrinkage shows the exact influence of the silicon, and whether more or less is needed to produce the required qualities in the casting. To illustrate this the following are actual records of three mixtures of Southern pig iron. Each mixture shows a close correspondence between shrinkage and the actual silicon. The last two mixtures show that the same percentage of silicon did not exert the same influence as in the first mixture, because there was less carbon for it to act upon.

It is fortunate that a given percentage of silicon does not, in every case, produce the same result in different mixtures of iron, because it enables the founder to vary the irons, without changing shrinkage or silicon, until he has obtained the greatest possible strength.

Diffusion of Silicon in Cast Iron.—Silicon is more unevenly diffused than any other element. It has been supposed that if the product of a blast furnace could be caught in a mixing ladle before it was run into the pig bed, an iron would be produced which would make castings of homogeneous chemical composition. If in Table VII we subtract the lowest record in a series from each other record, the remainder will show the excess of silicon in each test bar poured from iron which was supposed to contain the same percentage of silicon.

Series 1 was made of low silicon Iroquois pig iron, just as it came from the furnace; the silicon was, therefore, as evenly dif-

fused as it would be in any iron. The average silicon in the test bars was .80 per cent. The variation was .16 or an average of .08 per cent, which represents the diffusion. Series 19 was probably made of pig irons of very nearly uniform composition, and the average silicon in all test bars was .77 per cent. The variation was .19, with an average of .09. Series 16 was made of No. 1 Hinkle pig iron and uniform scrap. The average silicon in test bars was 1.76. The variation was .29 and the average .15.

Series 18 was made from pig irons of nearly uniform composition and good scrap. The average silicon in the test bars was 2.06, with variation .42 and an average of .24.

Series 15 was made from Southern pig iron with silicon from 2.00 to 3.50, and a silvery iron with silicon 5.00 per cent. The average silicon in test bars was 3.51, the variation was .46, and the average .22.

The iron of Series 19 and of 18 was caught in a 1,200-pound mixing ladle, and then into a 600-pound ladle, from which it was transferred to small pouring ladles. The pig irons were of nearly uniform composition to begin with, and the mechanical mixing was as perfect as it could be made, and yet there was a variation of .29 and .42, with averages .15 and .24, showing that mechanical mixing will not insure uniform diffusion. The single pig iron of Series 1 was melted in a clean cupola, and yet there was a variation of .16 and an average of .083.

Series 15 is an example of the practice of imparting silicon by a low silicon silvery iron. The iron was melted at the rate of eleven tons per hour, and was caught as fast as it melted, and no effort was made to obtain even diffusion. The variation of .46 and average of .22 shows that as perfect diffusion may be obtained without as with the mixing ladle. Series 2 and 6 are made from the same pig iron as Series 1, with increasing additions of a 10 per cent ferro-silicon. The diffusion of silicon is very irregular, but the average variations increase as the silicon increases, showing in connection with the other series that the diffusion is less complete as silicon increases in quantity. Comparing Series 2 to 6 with the other series, and especially with 15, it is evident that it is not possible to obtain a uniform diffusion of silicon when very high silicon iron is used.

Loss of Silicon in Remelting.—An analysis of drillings from three pigs of Iroquois pig iron by Mr. C. D. Chamberlain gave .88 per cent, and an analysis of drillings from twenty-five pigs by Messrs. Dickman & Mackenzie gave .98 per cent silicon. The analysis of each of the six sizes of test bars of Series 1 showed a variation of silicon between .72 and .83, or the same variation as the two analysis of the pig iron. The average silicon in the six castings was .80 per cent, showing a loss during the remelting of .08 to .18 of silicon, and indicates that there is a loss of as much as 10 per cent of the silicon in the iron during remelting in a cupola.

There could not have been a more careful mixture of iron to produce given percentages of silicon than in the Series 1 to 6, and an excess of silicon was added, for it was expected that there would be a loss in remelting. The calculated and average silicons, by analysis, are shown in Table IX.

TABLE IX.—LOSS OF SILICON IN MELTING.

No. Series.	1	2	3	4	5	6
Calculated Silicon	1.00	1.50	2.00	2.50	3.00	3.50
Silicon by Analysis	.80	1.21	1.88	2.01	3.19	3.04

To show how impossible it is to produce an exact percentage of silicon in castings, even by an analysis of pig iron, Table X gives the calculated and actual silicons in six crucible heats. The Iroquois pig iron was supposed to contain .88 per cent of silicon. The additional silicon was added by the 10 per cent ferro-silicon, and no excess was added to make up for loss. The variation in silicon, as shown by the analysis of Mr. E. E. Mains, indicates that there must have been an unequal diffusion of silicon in the material used.

TABLE X.—LOSS OF SILICON IN MELTING.

Silicon Calculated	1.00	1.50	2.00	2.50	3.00	3.50
Silicon by Analysis	1.23	1.64	2.04	2.25	3.10	3.49

These examples seem to prove that it is possible to obtain simply an approximation of the silicon in a pile of pig iron, and

that it is much less possible to obtain the percentage of silicon in a pile of scrap, and that having obtained an approximation by analysis, the loss of silicon during remelting, and the uneven diffusion of silicon in the casting, make it possible to obtain, by an analysis of the original materials, only an approximation of the percentage of silicon in the casting, and that a prediction of the percentage of silicon to be found in the casting must, from the nature of the case, be somewhat of a guess.

An analysis of the casting itself gives the only reliable information, and this is only approximate from the uneven diffusion of silicon. A measure of the shrinkage of one-half inch test bar, poured from the same iron as the casting, gives an accurate measure of the influence of silicon.

TABLE XI.

	Series.	Per Cent. of Combined Carbon.					
		½"Sq.	1"Sq.	2"x1"	2"Sq.	3"Sq.	4" Sq.
Iroquois.....	1	1.46	1.25	1.05	.80	.76	.70
	2	.70	.54	.59	.56	.54	.60
	3	.48	.45	.42	.37	.34	.13
	4	.45	.48	.43	.36	.11	.50
	5	.35	.16	.20	.11	.10	.....
	6	.37	.38	.30	.15	.11	.08
Southern.....	15	.10	.09	.09	.09	.11	.08
C. G. Bretting & Co.....	16	.49	.78	.73	.49	.58	.44
Bement, Miles & Co.....	18	.45	.52	.50	.24	.12	.11
A. Whitney & Sons.....	19	2.95	.99	.81	.81	.87	.89

Combined Carbon and Physical Quality.—Comparing Table XI with Table VII, we find that combined carbon decreases as silicon increases. Comparing with Table VI, we find that shrinkage and combined carbon vary together, and comparing each of the size of test bar we find that both silicon and slow cooling generally decrease combined carbon as well as shrinkage. The decrease of combined carbon does not produce the decrease of shrinkage, but both are decreased by slow cooling. Slow cooling

does not always decrease combined carbon, but it always decreases shrinkage, as shown by Series 2, 15, 16 and 19. If we compare combined carbon with strength in Charts I and II, we find that the strength of the 1-2 inch square test bar increases with the decrease of combined carbon. The way silicon prevents brittleness is by diminishing combined carbon. Slow cooling decreases strength by making the grain open, and the same slow cooling decreases combined carbon. This decrease of combined carbon strengthens all sizes of castings by removing brittleness, but the increase in the size of grain is so much more rapid that the final effect of slow cooling is a decrease of strength, but it is not the decrease of combined carbon that decreased strength. To prove this, examine Series 2, 15, 16 and 19, in each of which the combined carbon is substantially the same for each size of test bar, and therefore the decrease in strength cannot be ascribed to any decrease in combined carbon, and yet the strength decreases exactly the same as in other cases.

The opinion that combined carbon produced strength originated in the examination of such series as No. 1, where the strongest castings contained a considerable amount of combined carbon, and also because the foundryman has discovered that pig iron, which contains a large percentage of combined carbon, produced the strongest large castings. As a general thing low silicon, high combined carbon, and a close grain go together, but it is the close grain that produces strength. The slow cooling decreases combined carbon in such low silicon iron and thus prevents the brittleness which made the 1-2 in. casting weak, and thereby makes the larger casting strong, and in such low silicon iron slow cooling does not increase the size of grain as much as when there is more silicon.

TABLE XII.

	Series.	Per Cent. of Graphitic Carbon.					
		½"Sq.	1"Sq.	2"x 1"	2"Sq.	3"Sq.	4" Sq.
Iroquois.....	1	2.36	2.60	2.83	3.08	3.05	3.13
	2	3.20	3.32	3.24	3.33	3.32	3.31
	3	3.21	3.28	3.32	3.40	3.36	3.55
	4	3.10	3.24	3.27	3.41	3.60	3.25
	7	3.19	3.40	3.34	3.47	3.38	3.42
	6	3.01	3.08	3.08	3.24	3.19	3.23
Southern.....	15	3.03	3.01	3.07	3.06	3.03	3.11
C. G. Bretting & Co.....	16	3.30	3.10	3.08	3.32	3.22	3.31
Bement, Miles & Co.....	18	2.90	2.83	2.92	3.06	3.11	3.20
A. Whitney & Sons.....	19	.79	2.86	2.98	3.00	3.02	2.97

Graphitic Carbon and Strength.—As graphite increases in proportion as combined carbon decreases, it has been inferred that the greater the percentage of graphite the weaker the casting. It has also been supposed that the flakes of graphite separated the grains of iron, and in that way cut up the casting and weakened it. It has also been supposed that the amount of graphite determined the size of the grain and therefore weakened the casting. The reasoning which applied to combined carbon, if reversed, also applies to graphite, but there are other proofs. The size of the grain and the size and location of the spaces between the grains is determined by the slowness of cooling before the graphite is formed. A casting one inch square and two feet long, cooled in its own mold, becomes perfectly solid in one minute, but the graphite is not wholly formed until it has been solid for ten minutes. When the necessary temperature is reached, the combined carbon changes to graphite, which drops into the spaces between previously-formed crystals of iron. (Trans. Am. Soc. Mech. Eng., Vol XVI, page 1124). A comparison of the series presented will fail to discover any relation between graphite and strength.

TABLE XIII.

	Series.	Per Cent. of Total Carbon.						Average Per Cent.
		½"Sq.	1"Sq.	2"x 1"	2"Sq.	3"Sq.	4"Sq.	
Iroquois.....	1	3.82	3.85	3.88	3.88	3.81	3.83	3.845
	2	3.90	3.86	3.83	3.89	3.86	3.91	3.875
	3	3.69	3.73	3.74	3.77	3.70	3.68	3.718
	4	3.55	3.72	3.70	3.77	3.71	3.75	3.700
	5	3.54	3.56	3.54	3.58	3.48	3.52	3.553
	6	3.38	3.46	3.38	3.39	3.30	3.31	3.370
Southern..... ..	15	3.13	3.10	3.16	3.15	3.15	3.19	3.146
C. G. Bretting & Co.	16	3.79	3.88	3.81	3.81	3.80	3.75	3.806
Bement, Miles & Co.	18	3.35	3.35	3.42	3.30	3.23	3.31	3.326
A. Whitney & Sons.	19	3.74	3.85	3.79	3.81	3.89	3.86	3.823

Total Carbon and Strength.—There must be a relation between total carbon and strength, but local conditions cause such variations that it is difficult to collect data to prove its influence. In the series reported in this paper there is considerable variation in total carbon, and yet from these records there is no relation apparent. It seems impossible to make test bars with carbon the only variable. There is also very little practical interest in the question, because the furnaceman cannot regulate the amount of carbon, and the founder cannot tell what percentage his pig iron contains, and cannot increase it. He can add wrought-iron scrap and thus diminish it, but the experiment does not show the influence of carbon, because such addition closes up the grain of the casting and thus increases strength, and renders the experiment useless as a test of carbon.

Diffusion of Carbon in Cast Iron.—The remarks regarding diffusion of silicon apply equally to all elements. Probably a variation of .05 is as near as can be expected, and the extremes of variation will be 0 to .12. Remembering that Series 18 and 19 were taken from a mixing ladle, the wide variation in the diffusion of carbon in these series is surprising.

Phosphorus, Sulphur and Manganese in Cast Iron.—The variation of phosphorus and sulphur is sufficient to show their influence

in ordinary castings, but they do not seem to decrease strength, or to exert any other injurious influence.

Phosphorus and manganese are very evenly diffused, while sulphur is very unevenly diffused.

TABLE XIV.

	Series.	Per Cent. of Phosphorus.					
		½"Sq.	1"Sq.	2"x1"	2"Sq.	3"Sq.	4"Sq.
Iroquois	1	.211	.213	.214	.215	.216	.216
	2	.273	.269	.270	.271	.272	.270
	3	.270	.267	.268	.267	.266	.267
	4	.284	.283	.281	.280	.283	.281
	5	.333	.331	.330	.327	.325	.329
	6	.300	.299	.296	.298	.297	.299
Southern	15	.980	.975	.972	.972	.971	.973
C. G. Bretting & Co	16	.309	.330	.327	.325	.328	.330
Bement, Miles & Co	18	Average, .342 per cent.					
A. Whitney & Sons	19	" .353 "					

TABLE XV.

	Series.	Per cent. of Sulphur.					
		½"Sq.	1"Sq.	2"x1"	2"Sq.	3"Sq.	4"Sq.
Iroquois	1	.056	.054	.050	.046	.049	.041
	2	.046	.040	.040	.039	.039	.039
	3	.032	.030	.030	.033	.036	.030
	4	.045	.046	.047	.040	.044	.044
	5	.017	.021	.027	.031	.030	.030
	6	.034	.033	.034	.033	.028	.028
Southern	15	.088	.093	.088	.089	.087	.089
C. G. Bretting & Co	16	.025	.030	.031	.029	.030	.029
Bement, Miles & Co	18	Average, .052 per cent.					
A. Whitney & Sons	19	" .101 "					

TABLE XVI.

	Series.	Per cent. of Manganese.					
		½"Sq.	1"Sq.	2"x1"	2"Sq.	3"Sq.	4"Sq.
Iroquois	1	.35	.36	.37	.35	.34	.36
	2	.31	.30	.30	.31	.30	.32
	3	.50	.51	.49	.46	.51	.48
	4	.35	.30	.32	.33	34	.35
	5	.36	.39	.38	.37	.37	.38
	6	.43	.45	.41	.40	.44	.43
Southern	15	.50	.49	.50	.50	.49	.51
C. G. Bretting & Co	16	.57	.38	.37	.38	.36	.38
Bement, Miles & Co	18	Average, .354 per cent.					
A. Whitney & Sons	19	" .350 "					

Some little discussion ensued in regard to points brought out in the paper, in which Messrs. West, Lanigan, Beckett, Weyhenmeyer, Webster, Treat and others took part.

Mr. S. Groves, of Taylor, Wilson & Co., Pittsburg, Pa., then read an interesting paper on the subject, "Gear Molding and Gear Molding Machines," illustrating his paper by sketches on the blackboard.

E. H. Mumford then read a paper by Mr. Harris Tabor, of Elizabeth, N. J., on the subject, "Molding Machines and Their Applications," as follows:

"MOLDING MACHINES AND THEIR APPLICATIONS."

The closing quarter of the nineteenth century will always stand out as the progressive age. Within its period we have seen a revolution in manufacturing processes in nearly all the branches of the iron trades, a revolution so thorough in many departments that scarcely a trace of old methods remains, and where a trace is found there is very little left to bear it company. This industrial revolution is, primarily, the result of labor-saving machinery, and labor-saving inventions are the secondary result of this revolution. In the trades which were first to adopt newer and better methods

we find the greatest general progress, and we still find these trades keenly alive to everything which will reduce cost and simplify production. No matter how small the gain, if the cost of a machine can be made to give a better return than the money invested in the business, the new device is adopted. The manager of a plant for building locomotives once said to the writer that if he could be assured any piece of machinery would reduce the labor cost of an operation in his machine shop 4 per cent he would buy it. This is the spirit which underlies the most progressive trades in this country, and it is a similar spirit which is dominating manufacturing Germany so thoroughly that she is now England's strongest competitor in all the iron trades.

The foundry stands midway between the two iron industries which have done most to improve manufacturing conditions, and it depends on both. One feeds its cupola and the other buys its product. I refer to the blast furnace and machine shop. In the case of the former there have been such improvements made in smelting ores that a furnace of twenty years ago cannot afford to run except in times of prosperity and good prices. When pig iron drops in value the old furnaces go out of blast, and they remain out until prices advance enough to warrant resumption or they are remodeled by the engineer specially trained in combustion, fusion and chemistry.

Labor-saving machinery has made its highest record in the machine shop, which is your best customer. Take any line of manufacture you please, the locomotive, the stationary engine, the mower and reaper, and, in smaller articles, the sewing machine, typewriter, watch, bicycle, gun, etc., and you marvel how such things, with their multiplicity of parts, can be made and sold so cheaply, and you marvel also at the fine workmanship which characterizes them. As you go through a modern machine shop you wonder no longer. You there see the combined effect of the machine builder and toolmaker automatically doing the most skillful work at minimum cost. The screw machine, in the hands of a boy, is turning out work at a cost but little above that of raw material; the milling machine, operated by help skilled in nothing else, is making shapes with a precision that will defy the

skill of the best vise hands, at a fraction of the old cost, and the turret lathe is doing work quite as wonderful. These are the machines which have done much to revolutionize machine shop practice and create new industries. And they have made the foundry business better by an increased demand for castings. Just in proportion as the cost of manufacture is reduced the demand for articles of commerce is increased by more general use. Take, for instance, the lawn mower, a product of the foundry and machine shop; when it sold for $25 it was a luxury in which few indulged, but with a selling price one-sixth that amount it is a necessity which goes with every household grass plot. It is so with nearly every article of manufacture. There are products of the foundry which would be multiplied if their cost could be lessened sufficiently.

The molding machine is destined to bear the same relation to the foundry that labor-saving machinery bears to the machine shop, and its influence will be quite as beneficial. The foundry needs such help more than her machine-shop neighbor, for her labor conditions are more merciless and exasperating. These conditions do more than interfere with immediate shop management; they have a bearing on supply and demand which bodes ill when business again comes to you. The Iron Trade Review, a journal which discusses the various phases of the iron industry with unusual care and intelligence, illustrated one condition of your labor, in a last year's issue, so well that I quote it. If any of you are dividing the management of your foundries with committees it will have a significant interest:

"Careful investigations have determined that molders, on the average, work from fourteen to fifteen years at the trade. The union allows one apprentice for every eight molders in addition to one for the shop. In a foundry containing eighty molders there could be, on this basis, eleven apprentices. Counting a four years' apprenticeship for each, the shop would produce an average of 2 3-4 new molders each year. An average life in the trade of fourteen years for the eighty molders means that their ranks are diminished at the rate of 5 5-7 a year. The supply from the ranks

of apprentices is thus less than half enough to meet the demand. Immigration supplies a portion of the deficiency. Machine molding, moreover, is lessening the demand for skilled labor in the foundry. But with all allowance made, there is still a gradual curtailment of the supply of good molders. Stove manufacturers had this question before them as the most serious problem connected with the management of their foundries. Little has been heard from it in the past two years because foundry outputs have been small and few molders have had uninterrupted employment. If the same rate of improvement noted in the past three months continues through the remainder of the year, 1896 may bring with it fresh reminders of the artificial scarcity of molding skill created by union apprenticeship regulations."

The Review might have added that long periods of depression, like the present, tend to decimate the molders' ranks faster than the death rate.

These are the conditions in the foundry trade which make such a great range in prices for castings. If you investigate the molders' wage rate throughout the country you will understand why you meet such low quotations in competition. For illustration we will take an order recently placed in New York. The specifications called for 20,000 castings 24 inches long by 6 inches wide, 1-4 inch thick at one end and 3-8 inch thick at the other end. There were four bids, the first being $40 per ton, the second $32, the third, made by a foundry which needed inside padding to keep up its organization, at $30, and the fourth bid of $19 made by a foundry 150 miles from New York. All the bidders except the last were in the neighborhood of New York, with a minimum wage rate for molders of $2.65 and $2.75 per day. The successful bidder had a wage rate depending on his conscience, or lack of one, and the necessities of his men. The writer knows that his highest pay for bench molders is $1 per day. With such a discrepancy in wages organized foundries cannot compete. You cannot meet such a wage rate, but you can reduce the amount of skill needed in your foundry and so square yourself with your rural neighbor.

That quality, the molders' skill, on which you depend when business revives, cannot be made at will. If there is a shortage you cannot buy it as you would pig iron and sand; you must train it and wait during the training process. With apprentice laws in nearly every State against the interest of the foundry, and with existing union rules limiting the number of apprentices, this is not an easy task. What is needed in the modern foundry is a capacity for expansion and contraction to suit the fickle demand of trade, without seriously interfering with an economical shop organization. The molding machine will help you to this.

There is nothing in the mechanical line simpler than a good molding machine. The machine-shop favorites are complicated when compared to it. Its operation is simplicity itself, and the training necessary to turn a fair laborer into a good operator is reduced to scarcely more than ability to handle shovel and flasks. The one lesson to be learned, that of tempering sand, may be left to the foreman or his assistant until the operator learn to distinguish by touch the right temper. No matter how busy you may be or how difficult it is to find good molders, there is always a plentiful supply of muscle, and it is always amenable to shop rules and conditions.

The application of a good molding machine is quite as unlimited as that of other labor-saving devices. With a fair amount of patience on the part of the manager it may be made to cover a large range of work. While its operation does not call for skill beyond training in handling machine, good common sense and reasonable care must guard it. The sand must be kept at the proper temper, cores must be as carefully made as for hand molding, and the pouring must be done to suit the castings. These are details easily controlled in a well-managed foundry. You must dispense with molders' skill, as far as possible, if you would lessen your cost and meet competition, and just in proportion as this is done, the management of your foundry becomes easier.

Within the past fifteen years the relation of foundries to market demands has undergone changes which have escaped the notice of many of you. Old plants have been enlarged and made more efficient and many new foundries have been built. In any part of

the country you please you will find that the general capacity to produce castings has grown much faster than any natural demand for its product in ordinary business times. This means that with a volume of business which would have been more than satisfactory a dozen years ago, the less favored of you are still running light, in other words, like hungry competitors you are striving for business, at reduced prices if necessary. You cannot look for the hoped for difference between cost and selling price until all foundries are fairly filled with orders, and it is only at intervals that you may expect such a condition of trade.

The tendency of the past ten years has been to gradually lower prices without a corresponding reduction in cost. The burden of overproduction, or underconsumption if you will, falls on the business management. The improved demand which marked a brief portion of last year added to your cost sheets without giving increased value to a ton of castings. It is only a boom in business, which few of you expect, that will help you at the selling end of your business. The problem before you is, with continued low values for castings, even in times of business activity, how can you meet the new conditions? If any of you can make up for the reduced profit per ton, by an increased tonnage, you are fortunate. But it was the disposition to increase tonnage for this purpose in the past that made new foundries plentiful and old foundries more prolific. If you cannot sell for more than you are now getting, or if you cannot get what you deem full value for your wares, continued existence demands a reduction in your cost wherever you can make it. With the pig-iron market in much the same condition as your own, you cannot look for comfort in that direction. Coal values enter so little in the cost of your melts that market changes in that material cannot seriously affect you. Next to pig iron, in cost, comes the labor account, and it is the one item in the cost of castings which has not been materially reduced.

Here, then, seems to be your most fruitful field for operation. It is the disposition of human nature to help the fellow-man. None of you would reduce your labor to the miserable pittance paid by your meanest competitors, but you must reduce the totals of your

cost sheets in some way. Labor-saving appliances seem to offer the best plan, and you naturally turn to that item which is the greatest burden, molders' skill.

A good molding machine, with plenty of nerve and determination back of it, will do much for you. As you investigate its application you will be surprised at the shapes and quantities it will mold if assisted by ingenuity and skill, such as have been used in the development of the milling machine and turret lathe. Let your patternmaker and the foreman in charge of your green sand foundry or molding machines feel that they are as much concerned with the success of your machines as you are. Give them the same play of their ingenuity as they enjoy in arranging for difficult core work, etc., now and make them assured that the machines are as much a part of their regular equipment, and that they are as responsible for their successful and proper use as for that of any other tool or material. When this is done you will have overcome the most serious obstacles to the introduction of molding machines.

It is a mistake to assume that molding machines are antagonistic to the molders' interest or to the interest of labor. Under the present rules limiting the number of apprentices there will always be enough work, with average business conditions, to keep skilled molders employed; machines will take the brighter men from the laboring class and elevate their condition, at the same time making the foundry organization more efficient.

Briefly, the main advantages which follow the introduction of good molding machines may be summed up as follows:

First, economy of production; second, uniformity in size and weight of castings; third, lessened machine shop cost when castings are to be machined or fitted; fourth, a greater product from one set of patterns in a limited time; fifth, a capacity for expanding and contracting your plant, to suit trade conditions, by adding to or taking from the machines labor which is easily obtained; sixth, and quite as important as any, the ability to run your foundry as you will and with a view to profit.

Papers by Dr. Edward Kirk, of Philadelphia, and Mr. E. C. Brooksbank, of Ward & Nash, Boston, were ordered to be entered on the minutes as read. Following are the papers:

"CUPOLAS AND CUPOLA PRACTICE UP TO DATE."

By DR. EDWARD KIRK.

There are three kinds of furnaces employed in the melting of iron for foundry work. They are known as the pot furnace, reverberatory furnace and cupola furnace. These furnaces differ from each other in construction and principle of melting, and in the days of poor fuel their employment in the melting of iron for special work was considered necessary to the production of good castings. But with the discovery of veins of coal more suitable for melting and with the advancement made in the manufacture of coke, the amount of deterioration of iron by impurities in the fuel has been reduced to a minimum, and the furnace that will melt with the smallest per cent of fuel has been almost universally adapted as a foundry furnace, while the fuel that melts iron most rapidly has almost entirely taken the place of other forms. Charcoal, the furnace fuel of years ago, is only used in foundries located in isolated districts, where other fuel is not obtainable. The use of hard coal in melting is almost entirely restricted to the anthracite coal fields, and coke has become the universal fuel for foundry work.

In the pot furnace one ton of coke is consumed in melting a ton of iron (2,240 lbs.). In the reverberatory furnace, from 10 cwt. to 20 cwt. of coke is required to melt a ton of iron. In the cupola furnace, a ton of iron may be melted with 172 lbs. of coke. It will thus be seen that the cupola melts iron with a smaller per cent of fuel than either of the others. To melt in a cupola with the small amount of fuel stated, the cupola must be properly constructed and managed. This is not always the case, and the consumption of fuel, as a rule, is much greater, but is still not so great as required in either of the other furnaces. To reduce the amount of fuel required to the smallest possible amount, a cupola must be of a size that will admit of running it to its fullest capacity in melting a heat. The tuyeres must be placed low to prevent wastage of

fuel in the bed and the charging aperture must be placed high to utilize all the heat of the fuel in heating the stock and preparing it for melting before entering the melting zone.

The rule for charging a cupola is to place three pounds of iron upon the bed to each pound of fuel placed in the bed, and ten pounds of iron upon the charges of fuel to each pound of fuel in the charge. This rule is not always followed accurately, but it is approximately followed, and when a cupola is so large that the entire heat is melted upon the bed in one charge (according to this rule), only three pounds of iron is melted to the pound of fuel. When ten charges are melted in the same cupola, with the same bed, eight pounds of iron are melted to one of fuel. The greater the number of charges the less per cent of fuel required in melting, and it is only by melting a large number of charges and keeping the cupola in blast for a great many hours that the small per cent of fuel I have stated as sufficient to melt a ton of iron can be realized.

Foundrymen, as a rule, cannot have their cupolas in blast all day, and are compelled to use large cupolas to melt the amount of iron required for their work in a given time. Others prefer to melt their iron rapidly; and it is a question for each foundryman to decide for himself whether it is more economical to use a large cupola in melting and save time, or a small one and save fuel in melting.

Tuyeres should be placed from 2 to 6 inches above the sand bottom, and the height they are placed is from 2 inches to 6 feet. The general height for heavy work is from 18 to 36 inches. The placing of tuyeres at so great a height is productive of great waste of fuel. The function of fuel placed below the tuyeres is to support the stock in a cupola. It takes no other part in melting, and is not consumed in melting the longest heats. Its temperature, when a cupola is in blast, is below that of the melting zone, and molten iron in its descent through the fuel in a large bed to the bottom of a cupola is not superheated. The temperature of such iron is so reduced that hot iron can only be tapped from a cupola with high tuyeres when the molten iron passes down through the

fuel under the tuyeres in such a large volume and so rapidly that it is not chilled in its descent.

While the fuel placed under the tuyeres is not consumed in melting, it is heated to so high a degree and ground up to such an extent in the dump, that it is rendered worthless as a cupola fuel. Thus every pound of unnecessary fuel placed in a cupola by using high tuyeres is a waste. It is claimed by many foundrymen that it is necessary to have tuyeres placed high to collect and keep iron hot for a large casting. This is one of the fallacies handed down to us by our forefathers in the foundry business. Iron can be drawn from a cupola with low tuyeres so much hotter that it can be kept in a ladle for any given length of time, when properly taken care of, at a higher temperature than is possible in a cupola with high tuyeres.

In all cases, tuyeres should only be placed at a sufficient height above the sand bottom to admit of molten irons mixing for hand-ladle work, and to give sufficient time between taps for removing and replacing large ladles for heavy work.

Low charging doors are another legacy from the olden time. The volume of heat escaping from low cupolas was so great that many attempts were made to utilize the waste heat for supplying cupolas with a hot blast. Other attempts were made to divert the heat into side chambers for heating the iron prior to charging, but this feature of the old cupolas has been displaced more rapidly by modern ideas than the high tuyere. Cupolas in which charging doors were formerly placed 6 to 8 feet above the bottom, now have them placed 10 to 15 feet above, and even higher; and all the heat that escaped from the low cupola is now utilized in heating stock in the cupola prior to melting.

The highest cupolas in use at the present time in this country are those of the Carnegie Steel Works, Homestead, Pa. The charging apertures in these cupolas are placed 30 feet above the iron bottom. The heat is employed to so great an extent in heating stock prior to melting that it has not been found necessary to line the stacks. The heat escaping from the cupolas, even when the stock is low, is not sufficient to heat the iron stacks. A cupola must not only be properly constructed to do economical melting

but it must be properly managed. In every cupola there is a melting zone or belt in which iron is melted. Above or below this zone it cannot be melted in a cupola; but it may be melted on the upper and lower edge of the zone, and in either case a dull iron is the result. The exact location of the melting zone is determined by the volume of blast. A large volume places the zone a few inches higher, and a small volume puts it a few inches lower. For this reason cupolas of exactly the same construction frequently have higher and lower melting zones and require a greater or less amount of fuel for a bed. The size and arrangement of tuyeres often increase or diminish the depth of a melting zone; to obtain the best results in melting, the location and depth of the melting zone must be learned and the weight of the bed and charges varied accordingly.

The top of a melting zone may be readily determined by the length of time required to melt iron after the blast is put on. If iron comes down in five or ten minutes the iron on the bed has been placed within the melting zone. If iron does not come down for twenty or thirty minutes after the blast is on, the iron has been placed above the melting zone by too great a quantity of fuel in the bed and the delay in melting is due to the time required to remove the surplus fuel by burning it away. If iron comes down in five or ten minutes and is dull and at least three pounds of iron cannot be melted to one of fuel in the bed before iron comes dull, the bed is too low and the iron was not placed at the top of the melting zone when melting began. By noticing the melting in this way the height of the zone can readily be found and the exact amount of fuel required for a bed determined.

The depth of the zone can be found by increasing the weight of the first charge of iron until the latter part of the charge comes dull, which indicates that it is being melted too low in the zone and the charge should be decreased a few hundred weight. The quantity of fuel required for a bed and the amount of iron that can be melted upon it having been determined, tests are then made to ascertain the amount of fuel required in the charges and the amount of iron that can be melted upon each charge.

The amount of fuel required in each charge is the amount that will restore the bed to the same height above the tuyeres that it was before melting the first charge. This is found by increasing or decreasing the fuel until the melting becomes continuous and there is no variation in the temperature of the iron at the end of each charge. A stoppage or slacking in the melting indicates that the charge of fuel is too heavy and the iron upon it is placed above the melting zone. Dull iron at the latter end of a charge indicates that the charge of iron is too heavy and so on throughout the heat. By carefully noting the melting in every part of a heat, the peculiarities of any cupola in melting may be readily learned and a large amount of fuel saved.

These rules for melting are not always followed, and in nine cupolas out of ten too great an amount of fuel is consumed. It is a common practice of melters gradually to increase the fuel in charging. When iron comes dull they attribute it to poor fuel or not enough of it. In either case more fuel is the remedy applied, and as a rule dull iron and slow melting are the result. Fast melting and hot iron are not possible with too large a quantity of fuel in a cupola. The reason for this is that with an excess of fuel the iron is placed above the melting zone and the extra fuel must be consumed before iron can come within the zone. The result is slow and irregular melting.

Iron held just above the zone for any length of time is heated to such a degree that when it enters the melting zone it melts rapidly in one mass and its descent through the melting zone in a molten state is so rapid that it is not superheated and drops through to the bottom of a cupola a dull iron. Slow melting is always the result of an excess of fuel, and dull iron is more often the result of an excess than of a deficiency of fuel.

The per cent of fuel required in melting when a cupola is properly constructed and managed depends entirely upon the length of time required to melt a heat. In short heats of two or three hours eight pounds of iron to one of coke may be melted and good hot iron made for light work, by careful management. The melting generally done in heats of this length is between six and seven to one. In long heats thirteen to one has been melted. But

this ratio is seldom maintained for any great length of time in cupolas, for the quality of fuel varies and foundrymen would rather use a little extra fuel than take chances of a bad heat. In heats requiring from one to six days to melt, the average melting is about ten to one.

It should be the aim of every foundryman to reduce his melting to a system. He should first see that the cupola is properly constructed, and then study its working in the manner I have described. When this has been learned, a slate should be made out and given to the melter, indicating the exact amount of fuel to be placed in the bed and charges and the exact amount of iron to be placed in each charge, also the amount of each brand of iron or scrap to be used. As the lining burns out and the cupola diameter increases, the weight of charges of fuel and iron should be increased to correspond with the enlargement of the cupola. An accurate cupola record should be kept, and the amount of fuel consumed in melting compared with each carload or lot of coke, to make sure that no extra fuel is being used by the melter. When such an account is accurately kept by every foundryman, the average of fuel consumption will be much less than it is to-day.

"THE SAND BLAST IN THE FOUNDRY."

By E. C. BROOKSBANK.

I feel some hesitation in addressing this meeting upon this subject, on account of having addressed the Foundrymen's Association upon the same subject a short time ago, and I now see before me many of the same gentlemen whom I had the pleasure of addressing upon the former occasion. I will, however, make my remarks as short as possible, trusting that the advantages of the process will be my justification, and would respectfully refer any one wishing a fuller statement of the subject to the Iron Age of March 12, 1896, where my previous paper is reported at length.

The method, stated shortly, consists of projecting a stream of sand or other abrasive powder, usually dry, but sometimes mixed with water, with more or less force and velocity to strike and pulverize the surfaces of glass, stone, metal and other materials upon which it is directed.

The abrasives used in the process include ordinary inland siliceous sand, sharp builders' sand, powdered glass, emery from fine to coarse, chilled iron sand and steel shot; and the stream of the powders is forcibly projected through variously formed nozzles by means of steam, by currents induced by exhaust air, by blasts of air and latterly and more conveniently by compressed air. Sand, from its plenteousness and general suitability, is mostly employed. The white beach sand of New Jersey is probably as good as can be found anywhere for general purposes.

The action of the sand blast is not cutting, not grinding, not abrading in any of the usual meanings of these terms. It is a true pulverization by the successive impact of the grains of flying sand. The sand acts much in the same manner, but on an infinitely reduced scale as artillery projectiles in breaching a masonry wall, each independently of all the rest. In this action it differs from anything that has preceded it and it still stands alone. As all know, the process consists simply in driving a stream of rapidly moving sand against the object to be operated upon. How the sand is given velocity or how the work is presented to the blast, are matters of indifference when examining the theory of the process. As the total action of the blast is but the summation of the action of the individual grains, the action of the individual grain is to be considered. If the single grain of the flying sand has no effect when it strikes the work, then no other grains will have any, and the sand blast will be without effect, no matter how long continued. If, however, the single grain of sand has any effect upon the object struck, then the blast will wear it away often at an extraordinary speed, as the number of grains propelled against it is very large, often as many as 5,000,000 per minute.

The cutting effect of this stream of flying projectiles upon brittle materials is produced by each grain chipping away and pulverizing a portion of the surface struck. Upon ordinary metals there is no chipping away or pulverizing done, but the metal instead of being pulverized is only bent and deformed upon its surface by the flying grains. The result is that no metal is removed, but a small indentation produced. Other grains striking in the immediate vicinity of this indentation simply shove the metal back

into it again and obliterate the effect of the first grain. Thus no effect is produced, but the surface is simply roughened by the indentations of the grains of sand. This is the normal effect of the blast upon all metals. If they are exposed for a long time to the action of the sand, as in a sand-blast machine, metals wear away because the surface metal is exhausted by the constant bending so that it at last breaks. If the blast is directed upon a piece of soft rubber the same action as in the case of the metal takes place, but in this case the elasticity of the rubber is such as to enable it to resume its original shape after the force of the impact has been expended in deforming it, and there is no residual effect whatever upon the rubber, the grain of sand rebounding with almost its original velocity. These three actions and the combinations of them explain all the different effects of the sand blast in cutting and refusing to cut various substances.

The use of sand of a proper degree of fineness is of great importance, as upon this depends whether comparatively many weak blows are desired for surface effects or fewer more powerful blows such as are desirable in cutting away substances. By the use of unsuitable sand, either too coarse or too fine, the work of an otherwise efficient machine can easily be reduced from 60 to 75 per cent. In the earlier practice with the sand-blast process, many forms of machines have been taken up and abandoned without having obtained any permanent foothold in the foundry. In a recently-designed machine, however, the points necessary for successful use in the foundry have been combined with others contributing to its economical use of the power supplied to it. And it is to its work that I particularly wish to call your attention. This machine uses air at all pressures, but those about ten pounds to the square inch are found to be the most satisfactory. By immersing the whole sand supply in an atmosphere of air at the above pressure, contained in a tight reservoir, the advantages of a purely gravity feed are obtained, uncomplicated by any questions of difference of pressure inside of the jet tubes and without. Then, by the use of a flexible tube of considerable diameter, the sand and air, in a mixed current, are carried to a point where they are to be used. Here the flexible tube is terminated by a hard chilled

iron cone, terminating in a tube of small diameter. In traversing this latter portion of its course the mixed current of sand and air increases its velocity inversely as the square of the diameter of the tube, and is finally discharged from the end of the blast nozzle at the full velocity due to the pressure behind it. An air-lock arrangement for transferring new supplies of sand into the sand reservoir, while still under pressure, and valves for operating and graduating the air and sand supply, with a suitable compressor for furnishing the supply of compressed air, complete the arrangement. This machine is comparatively new in this country, but has been used to a considerable extent in England and the Continent for cleaning off scale from sheet metal and castings and forgings. The machines are built in different sizes, and, of course, the output of work depends strictly upon the amount of compressed air that they use per minute. A machine using 60 cubic feet of air per minute requires three indicated horse power to run the compressor, which furnishes this amount of air compressed to a pressure of 10 pounds to the square inch.

At this volume and pressure the work accomplished on ordinary rolled steel plates is one square foot of scale removed per minute. Iron plate usually has thicker scale and requires slightly longer time. Forgings and castings differ so much in the nature of their scale, both from kind and heat of iron, kind of molding sand and several other particulars, that it is impossible to give any general rate which will be sure to suit more than the individual case which is considered. Trial is the only safe criterion.

USES OF THE SAND BLAST.

The recent improvements and inventions of Mr. Mathewson, manager of the Tilghman Sand Blast Co., Sheffield, England, have given a new impetus to the use of sand blast for a great variety of purposes. In metal it is used for the removal of the hard scale, so destructive to cutting tools, from castings and forgings. Among the applications are the removal of the scale from sheet iron and steel prior to enameling, galvanizing, nickeling, tinning, etc.; the cleaning of tubes and brazed joints largely used in bicycle works; sharpening the teeth of files; for granulating or

frosting electroplate, gilding metal, gold and silversmiths' work and jewelry; the reduction to clean metal surfaces of larger works, ranging from steel forgings of safes to armor plates; on stone, slate and granite, for incised carving and inscriptions in intaglio or relief; for cleaning off the grime from stone, granite and brick buildings, and in contrast to this last, for the most delicate drawing for lithography.

Another recent improvement in connection with the use of sand blast is the application of it in connection with tumbling barrels. These barrels run very slowly (two or three revolutions per minute), consequently there is little risk of breaking fragile castings, neither are the edges of them worn off and destroyed, as in the case of ordinary rattling at high speed. The castings are not cleaned by tumbling, but by sand blast inserted at one or both ends of the barrel. The usual time consumed in cleaning a charge of this barrel is from twenty to thirty minutes. The latest design of this machine is arranged at an elevation directly over the sand blast apparatus, which has two flexible tubes and nozzles. These are inserted into each end of the barrel, which is inclosed and provided with an exhaust fan to carry off the dust. The barrel is perforated with small holes, through which the sand falls through a hopper and directly back into the sand blast apparatus, thus making it almost automatic.

The ordinary method of attempting to produce a clean metallic surface on castings, forgings, etc., for these and other purposes is by pickling. This process, apart from its numerous well-known disadvantages, which make all who have anything to do with it wish to replace it with some other process, has a serious effect upon the internal structure of the iron, as the following reports of experimental results will show:

THE EFFECT OF PICKLING IRON AND STEEL.

The effect of pickling and rusting on the strength of iron and steel has been shown by A. Ledebur, of Berlin. Rails, joists and bars were subjected to various conditions: 1. In the condition as delivered. 2. After exposure for purpose of rusting. 3. Galvanized and exposed for a time. 4. Pickled in acid and tested at

once. 5. Pickled and kept for a time in a dry place. The pickling was done with sulphuric acid diluted with water in the proportion of 1-100. The samples were tested for transverse, tensile and compressive strains and under a falling weight, these experiments being made on the same sample for each of the five conditions. The bending tests with wrought iron joists showed substantially the same for all conditions; the maximum loads carried showed differences, being highest in the natural condition and lowest when freshly pickled. Rusting also produces a diminution of strength more apparent in the galvanized specimens than in those not galvanized. In the instances where the specimens were broken the diminution in strength is said to be very decided in the pickled and perceptible in the rusted specimens. The figures are: Breaking strain under condition 1, 35 tons; under condition 2, 33.9 tons; under condition 4, 32.7 tons; under condition 5, 29.6 tons and under condition 6, 30 tons. The steel specimens showed results which follow the same law.

When iron is placed in acid some of it is dissolved and hydrogen liberated. This gas is supposed to be of the nature of metal, and as such it combines with and forms an alloy with the iron, which becomes quite brittle until the iron is heated and the hydrogen is liberated, when it regains its tenacity. If a piece of wire becomes broken when it has thus become alloyed with hydrogen, and the end wetted, the bubbles of gas may be seen rapidly passing through the water. The condition of things was observed and investigated by W. Johnson, Manchester, and afterwards by Prof. Osborne Reynolds. The latter showed that if an iron tube be closed at one end and filled with oil and placed in an acid solution, hydrogen is liberated from the outside, which passes through the wall of the tube displacing the oil, so that the gas may thus be easily collected from the inside of the tube. There is a possibility, therefore, that when iron is rusting the hydrogen liberated may similarly combine with the iron and render it brittle or reduce its strength, and this is a question of much importance to engineers.

PICKLING HAS DISADVANTAGES.

Some interesting experiments in regard to the decrease in the strength of iron after being pickled and galvanized were recently reported in Tin and Terne. A dozen eye bolts, all precisely alike so far as could be perceived by external inspection, were carefully selected. Six of these eye bolts were laid aside and others sent away to be galvanized. A testing machine was not at hand, but six bolts were connected together, one being connected to each of the ungalvanized ones. Then they were placed between two pieces of iron, and the nuts screwed up until the eye bolts broke. Invariably it was found that the galvanized eye bolts were the ones to break, and not in one instance did the ungalvanized ones give way. Boat builders also state that galvanized iron is "rotten." They say that when great strength is required select the iron and have the fittings forged by a good smith, but do not have them galvanized. Galvanized iron is frequently used in places where little strength is required, but where rust would be objectionable. For this purpose galvanized iron leaves nothing to be desired, but where the full strength of the material is desired and rust stains are objectionable, the object may be obtained by cleaning them with the sand blast process and afterwards coating them by the cold galvanizing process, both of which methods are becoming well known and widely used for the above purposes.

The foregoing may be of more or less interest to you, but I take it that what more nearly concerns you, and which you may ask: "Does sand blast pay for foundry use?" I say yes. But as I said before, it is difficult to approximate on general work. I am safe in saying, however, that on ordinary iron, steel, brass and bronze castings, that one man operating a sand blast apparatus consuming 120 cubic feet of air per minute will clean more surface and remove more cores in a given time than is possible for from six to ten men to do with hammers, chisels and brushes. And the finished work left by the sand blast is infinitely better than what can possibly be done by hand laborers. I have proved this repeatedly. I have never yet seen the burnt sand or scale that sand blast would not remove, and remove rapidly. Not only is

it a great saving in time and labor in the actual cost of the castings, but a further saving is made in castings to be machined. The removal of the outside itself is a great saving on tools, and in many cases the tools can be run at an increased speed. This particularly refers to milling cutters.

Difficult and intricate cores are readily removed and have greatly astonished some of our well-known engineers. One peculiar thing in cleaning steel castings in which large quantities of wire nails are used is the cores. When subjected to the sand blast the sand is eaten away first and subsequently the nails will fall to the ground, sand blasted perfectly clean and in condition to be used over again. I could give you many instances that have come under my notice of the quick removal of cores and will mention one that was accomplished in five minutes. This was considered to be a job of from three to four hours for one man with hammer and chisel. Quite a number of people who have adopted the sand blast recently, and who previously used facings, have discontinued the use of such and have assured me that the sand blast has enabled them to reduce the cost of their product.

In conclusion, would say that the only objection to the sand blast that can be found to its use in foundries is that it has an unpleasant trick of showing up defects and making them plainly discernible.

The committee on Constitution and By-Laws, through their chairman, Mr. A. Sorge, Jr., then presented their report. Mr. Pepper read the report as follows:

Mr. President, and Gentlemen of the National Convention of Foundrymen: We have the honor to submit to you herewith the report of your Committee on Organization in the form of a set of rules for the government of the American Foundrymen's Association, and we trust that our efforts will meet with your approval. Yours respectfully,

A. SORGE, JR., Chicago, Ill.
C. S. BELL, Hillsboro, O.
ROBERT TAYLOR, Pittsburg, Pa.
FRANK A. MAGEE, Boston, Mass.
JOS. BEST, Montreal, Can.

RULES OF THE AMERICAN FOUNDRYMEN'S ASSOCIATION.

ADOPTED MAY 13TH, 1896.

ARTICLE I.

NAME AND OBJECT.

Section 1. This Association shall be known as the "American Foundrymen's Association."

Sec. 2. The objects of this Association shall be the advancement of the interests of foundry operators, or all who are concerned in the casting of any kind of metal in sand or loam moulds, for any purpose; to collect for the use of the Association all proper information connected with the foundry business, to interchange experience, and encourage uniform customs and actions among foundrymen.

ARTICLE II.

MEMBERSHIP.

Section 1. The membership of this Association shall consist of three classes, to be called, respectively, Active, Associate and Honorary Members.

Sec. 2. Any person, firm or corporation engaged in the production of castings of any kind, as employer, superintendent, foreman, chemist, etc., may be elected an Active Member.

Sec. 3. Any person whose knowledge or services are valuable towards the objects of this Association may be elected an Associate Member.

Sec. 4. Any individual whose knowledge or services in connection with the objects of this Association have made him preeminent among his fellows may be elected an Honorary Member.

Sec. 5. All nominations for membership shall be made in writing to the Executive Board (addressed to the Secretary), who may, in their discretion, submit the nominee's name at the next regular meeting of the Association, when an affirmative majority vote of the Active Members present shall entitle the nominee to membership in his proper class upon compliance with the provisions of these rules within three months after the date of his election.

Sec. 6. Each member who has duly qualified shall receive an appropriate certificate, stating the date of his election and the class to which he belongs, the certificate to be signed by the President and attested by the Secretary.

Sec. 7. Only Active Members shall have the right to vote at the meetings of the Association and to hold office in same.

Sec. 8. A member shall only be expelled on a two-thirds affirmative vote of all Active Members present at a meeting subsequent to one at which definite charges of misconduct were preferred against him in writing.

ARTICLE III.

DUES.

Section 1. Each person, firm or corporation who has been elected to either Active or Associate Membership in this Association shall pay to the Treasurer the sum of $5.00 as an initiation fee before a certificate of membership shall be issued to him or it.

Sec. 2. The annual dues for each Active or Associate Member of the Association shall be $12.00, payable annually in advance.

Sec. 3. No dues or assessments of any kind shall be collected from Honorary Members.

ARTICLE IV.

OFFICERS.

Section 1. The officers of this Association shall consist of a President, eight Vice-Presidents, Secretary, and Treasurer, who shall together form the Executive Board of this Association.

Sec. 2. The eight Vice-Presidents shall be selected from the different sections of North America in the following order:

One from the New England States.
One from the Middle States.
One from the Southern States.
One from the Central Western States.
One from the North Western States.
One from the South Western States.
One from the Pacific States.
One from the British Provinces.

Sec. 3. The duties of the President shall be to preside at the meetings of the Association and of the Executive Board; to sign all certificates of membership, and to perform such duties as usually devolve upon a presiding officer.

Sec. 4. The duties of the Vice-Presidents shall be to act as President in cases when the latter is absent.

Sec. 5. The duties of the Secretary shall be to keep true and accurate records of all proceedings of the Association and Executive Board; to give proper notice of all meetings; to attend to all correspondence, notifications of elections, and do such other matters as may be directed by the Executive Board; and he shall attend to the proper selection and editing of all publications of this Association; he shall obtain papers on subjects of interest to the Association, and shall have the power, together with the President, to amend or reject any paper which they may not deem proper. They shall prepare a set of rules to be used as a guide for the consideration and publication of papers, which rules shall be submitted to the Executive Board for approval.

Sec. 6. The Treasurer shall be the custodian of all funds of the Association, and shall pay out such sums as may be ordered by the Executive Board, and may be required to give a bond for the faithful performance of his duties in such amount as the Executive Board shall demand.

Sec. 7. All the affairs of the Association shall be under the control and direction of the Executive Board, three of whom shall constitute a quorum for the transaction of business.

ARTICLE V.

ELECTIONS.

Section 1. All officers of this Association shall be elected by ballot by the Active Members of the Association at its annual meeting, a majority vote of those voting being necessary to election.

Sec. 2. All officers of this Association shall hold office for one year from the date of their election, and until their successors shall have qualified. In case of a vacancy in any office during the

year the Executive Board shall fill the vacancy for the unexpired term.

Sec. 3. At each annual meeting the President shall appoint a Nominating Committee of five, who shall present to the meeting before its adjournment a list of names to be voted upon for officers of this Association for the ensuing year.

ARTICLE VI.

MEETINGS.

Section 1. There shall be an annual meeting of this Association, the date and location of which shall each time be fixed by the Executive Board at least three months in advance, at which meeting all officers shall make annual reports in writing.

Sec. 2. The Executive Board shall meet at least once a year at such time and place as it may direct.

Sec. 3. Special meetings of the Executive Board may be called by the President at the request of any three members of said Board.

Sec. 4. Twenty-five members shall constitute a quorum of the Association.

ARTICLE VII.

AMENDMENTS.

Section 1.—These By-Laws may be amended at any regular meeting of the Association by a two-thirds vote of those voting, such amendment having been proposed in writing at some previous regular meeting.

ARTICLE VIII.

ORDER OF BUSINESS.

Section 1. The order of business shall be as follows:

1. Reading of the minutes of the last meeting.
2. Reports of Standing Committees and officers.
3. Reports of Special Committees.
4. Election of Officers.
5. Election of New Members.
6. Unfinished Business.
7. New Business.
8. Adjournment.

Sec. 2. Robert's Parliamentary Rules shall govern in all cases not hereinbefore specified.

After the reading of the report of the committee an animated discussion took place that was participated in by Messrs. Treat, Wiard, Sorge, Penton, Weyhenmeyer, Riehle, Lannigan, West, Groves, Bell, Beckett, Devlin, Ferguson and Brown, in which it was developed that the constitution as proposed was entirely satisfactory with the exception of the clause relative to membership, and after some debate an adjournment was taken to the Manufacturers' Club at 10 o'clock the next (Thursday) morning.

FIFTH SESSION.

MANUFACTURERS' CLUB,
Thursday, May 14, 1896 (10 A. M.)

Upon being called to order the Chairman announced to the convention that the first subject to be discussed was the constitution.

At the previous session it had met with unanimous approval with the exception of article regulating the membership, and called upon the Secretary to read Article II., governing that question. After it had been read the Chairman spoke as follows:

There was no objection to Section 1, but to Section 2; to that objection was raised because it would preclude the admission of men who are eminently identified with the foundry interest. It was not sufficiently elastic. Others made the objection that all delegates here should be entitled to full membership; then others held that this was a foundrymen's association and that the full membership should be composed of foundrymen solely; that all the allied industries should come under the head of associate members; that we should recognize their aid and efforts towards the creation of this association by the fact that we made them associate members. Those are the salient points as they were brought out by the different members. That seems to be the only article or clause that was objected to.

Mr. John M. Warner said that as a delegate to the convention and as one who had labored for the success of this gathering, he

would be satisfied to continue as a member under the clause governing associate membership. He was not a foundryman, but a "pig iron fiend," and knew that he would not have any voice in its government, and he thought others would feel the same way about it as well as himself.

Mr. Bell introduced the following amendment at the suggestion, he said, of some of the active members: To strike out Section 2, Article II., and insert:

"Any person, firm or corporation, engaged in the production of castings of any kind, as employer, superintendent, foreman or chemist, may be elected an active member, and any associate member may become an active member when recommended by the Executive Committee and approved by a majority vote of the association at any regular meeting."

There being no objection it was carried unanimously.

After some further discussion participated in by Messrs. Beckett, Bell, Treat, West, Blankley and Yagle concerning the power of the Executive Board to admit to membership those who might apply and were qualified without waiting for the annual meeting of the association, the following amendment to Section 5, Article II., was proposed by Mr. Bell and carried:

"The election to membership during the first year shall be made by the Executive Board, who shall be empowered to issue certificates for the class to which those elected are entitled."

Mr. Beckett then offered the following amendment to Article III, Section 1:

"After the words 'him or it' add 'excepting that charter members taken in during the first six months shall be exempt from the payment of initiation fees.'"

After the adoption of the aforesaid amendments the constitution was adopted as a whole.

Mr. S. Groves, of Pittsburg, then offered the following resolution:

That in recognition of the special services rendered by Mr. Howard Evans, the Secretary of the Foundrymen's Association

of Philadelphia, and Mr. John A. Penton, editor of THE FOUNDRY, in the work of calling together and organizing this association, that they be elected to active membership.

The Committee on Nominations, through their chairman, Mr. S. G. Flagg, then offered the following:

For President—Francis Schumann, Philadelphia.

For Vice-President—F. W. Gibby, Boston, New England States.

For Second Vice-President—Robt. G. Taylor, Pittsburg, Middle States.

For Third Vice-President—Henry Clay Evans, Chattanooga, Southern States.

For Fourth Vice-President—J. M. Sweeney, Chicago, Central Western States.

For Fifth Vice-President— ————, North Western States.

For Sixth Vice-President—W. S. Mosher, Texas, South Western States.

For Seventh Vice-President—Irving Scott, San Francisco, Pacific States.

For Eighth Vice-President—Joseph Best, Montreal, Canada.

For Secretary—John A. Penton, Detroit, Mich.

For Treasurer—Howard Evans, Philadelphia.

(Signed) STANLEY G. FLAGG, JR., Philadelphia, Chairman.
H. M. LANE, Cincinnati, O.
S. GROVES, Pittsburg.
J. A. BECKETT, Hoosic Falls, N. Y.
WM. FERGUSON, Chicago, Ill.

The committee felt that they were not sufficiently well informed concerning the foundry business in the North Western States and hence left that position vacant.

Mr. Schumann, while thanking the committee for the great honor they had conferred upon him, felt that it would be necessary for him to decline the honor. He said he was a very busy man and felt besides that the office should go to the Central Western States or Western States.

Mr. Groves, replying to the Chairman, spoke as follows: "I feel disposed to say something here; that is, I trust that Mr. Schumann will not take any decisive stand as he has intimated, and for these reasons: The committee in making their various considerations took the view that Mr. Schumann was the first President of the first powerful organization of this kind in the United States of America, and we further took into consideration the fact that this Foundrymen's Association has been established here in Philadelphia where we have been so royally entertained; and further, putting aside even this view, the manner in which Mr. Schumann has conducted this convention has been a splendid example of executive ability. Although he is a busy man, he has taken an interest in foundrymen's work; he is not only interested in foundry work, but he is an engineer of national reputation, and he has put aside any feeling of pride that he might have in the engineering interests of the country and has come down to the poor foundrymen. Mr. Schumann has taken hold of this work and he has made a success of this association here, and I do hope that he will not take the stand he has indicated, but that he will continue to accept our wishes and will help us to steer this work into safety for a year at least.

Mr. Beckett followed Mr. Groves in much the same line, saying that Mr. Schumann was largely to blame for bringing foundrymen to Philadelphia from all parts of the country and had done much towards organizing the foundrymen in Philadelphia and elsewhere.

Mr. C. A. Treat, of Hannibal, Mo., also urged Mr. Schumann to accept the nomination and recommended that the entire report of the committee be adopted. He said: "We who have come from the north have been right royally entertained here in Philadelphia, we appreciate the courtesies and desire in part to show our appreciation in a substantial way." The Chairman in replying said:

"I will tell you, gentlemen, what I will do; I will accept the nomination, provided you will agree to make up your minds right now that you will do all you can to be proud of being

foundrymen; don't come here and think that we are simply to have a little blow-out, and care nothing about the association, but let us see if we cannot have a name above the pig iron pile. I can see—in fact, I am certain—that you will have just as much pride as myself in advancing and raising the standard of foundrymen. We are not considered a separate industry. The Bureau of Statistics at Washington decided that the foundry was not a separate industry; they considered it an adjunct of a machine shop, but we know that to-day the foundry industry is eminently an industry of its own. A great deal has got to be done yet to bring it up to its proper level among other occupations. I say, again, if you will agree that you will aid me in building up the American Foundrymen's Association and will lay aside any little jealousies you may have, I will do my best to be deserving of your approval at the end of the year, and furthermore, of course, I am extremely thankful for the honor; I thought the committee had decided that they would suggest someone from the west.

A motion having been made to that effect, the report of the committee was carried unanimously.

Mr. Penton made some remarks, thanking the committee for the confidence they evidently had in him, and was followed by Mr. Evans, who spoke well of the committee's selection in certain respects.

The Chairman made a few complimentary remarks concerning the newly elected Secretary and Treasurer. He felt that wise selections had been made in that direction at all events.

Mr. Yagle moved that the Executive Board have power to regulate compensation of Secretary and any other person whose services would be required during the coming year. The motion was carried.

After a vote of thanks had been tendered the gentlemen who had called and made this meeting possible, those who had in any way contributed to its success, the Ladies' Committee, those who had extended invitations to the delegates to visit their establishments, and all who had been in any way instrumental in forming the association, the convention adjourned, it being understood the location of the next meeting would be a matter that would have to be settled by the Executive Board.

WESTERN FOUNDRYMEN'S ASSOCIATION.

The regular monthly meeting of the Western Foundrymen's Association was held Wednesday evening, June 17, 1896, at the Great Northern Hotel, Chicago. The President, A. W. McArthur, occupied the chair.

The Secretary read the following applications for membership: Jas. A. Brady (active), J. W. Reedy Mfg. Co., Chicago; C. O. Billow (associate), Chicago; A. H. Blackburn (active), of Fuel Economizer Co., Matteawan, N. Y.; Chas. S. Burt (associate), Chicago, and Edward A. Sumner (active), American Radiator Co., Detroit, Mich. On motion, the applicants were elected members of the association.

The Secretary read a paper by Thos. D. West, as follows:

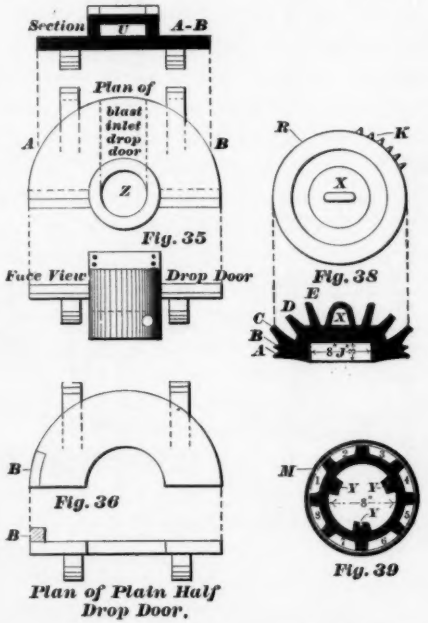
"POWER OF BLAST PENETRATION AND IMPROVEMENTS IN CENTER BLAST."

There has been much speculation as to the force of blast existing in the center of a cupola. Some have gone so far as to assert that the burning out of a cupola's lining at the melting point was due to the force of blast from the opposite tuyeres. The conviction that blast expends its power most largely at the entrance of a tuyere has been an incentive to the writer to utilize "center blast," and the economical results which he has obtained from its use have demonstrated to him that his convictions on this point are correct. A little experiment which the writer conducted recently will show any one trying it the inability of blast to exert any great power or pressure in the center body of a cupola. This experiment consists in simply getting into the inside of a cupola after the bottom is put up and holding a handkerchief at varying distances from the outside tuyere openings with the blast or fan running at full speed. In the 66-inch cupola shown in Fig. 40, having six tuyeres 3 inches by 16 inches, holding the handkerchief a foot away from the tuyere opening or inside surface of the cupola, the

blast had no perceptible influence on it. This was a revelation to the writer, as he thought before entering the cupola he would be smothered with the effects of rushing air, but was happily disappointed. Of course, the writer does not wish to imply by this that when a cupola is filled with fuel and iron, the blast will not penetrate further toward the center; but nevertheless, it is very far from exerting the same pressure at the center as it does at the entrance. To more fully prove this, it is but necessary to watch a cupola at the close of its heat, when the stock is settled down, say, about half way, so as to enable one to observe more directly the action of the blast. Here a careful observer will readily notice that the action of the blast is to turn upward right at the tuyere's entrance with but a very small percentage of the blast reaching the central body. In fact, the blast at the tuyere entrance creates such excessive combustion at the outer circle, that very hot flames will be seen turning upward right over the tuyeres, playing against the walls or lining of the cupola, with the center body of the cupola comparatively free from live combustion. We may, by reason of greater blast pressure, or a smaller tuyere area at its entrance to the cupola, penetrate the center body of the fuel in a cupola to a much greater extent than can be obtained with the ordinary pressure used. Blast furnace practice demonstrates to us what high pressures can do to force blast to the center, but we find such a practice in cupola work to be very objectionable, simply on the ground that small tuyere area or high pressures of cold blast cause rapid chilling or closing up of the blast passage at the front of tuyeres. For this reason we find high pressures or small tuyere areas, especially where coke is used, impractical or very objectionable in cupola practice, because of the cold blast. If any one will conduct the experiment cited above, of getting into a cupola to test with a handkerchief the extent of blast penetration, the author believes he will be brought to realize more than ever the utility of "center blast" for cupola practice.

Ever since the writer first introduced "center blast" proper in his paper before this association, in October, 1893, he has been continually experimenting to further improve and perfect center blast, with the idea of making it so simple and reliable that all founders would find it to their advantage to adopt such methods.

The objection to center blast, at the time of its introduction by the writer, was due to the difficulty of erecting same and connecting to blast attachments. By a study of this paper, those two objections will be found largely removed. In Fig. 40 is seen an arrangement designed by the writer, whereby the center tuyere is a permanent fixture, not requiring to be dropped with the bottom at the close of a heat, as is necessary with all other designs. This is only practical with cupolas over 50 inches inside diameter. For



cupolas below this size the author has designed the improvement seen in Fig. 37. The advantage of this construction lies in the "drop door" being so designed that it obviates the necessity of putting up and taking down blast pipe connections every "heat." It will be understood that in cupolas below 50 inches it is intended the center tuyere shall drop with the bottom at the close of a "heat." The writer has not, as yet, used the principle seen in the

blast inlet drop door shown in Fig. 37, but from his experience he knows that if the plan shown is followed, it will prove quite a convenience over other methods now being advanced.

As will be seen, the writer advises the use of outside tuyeres in connection with the center tuyere, providing they are made independent of each other in action, by reason of valves or blast gates, as seen in Fig. 37, whereby the blast pressure can be perfectly con-

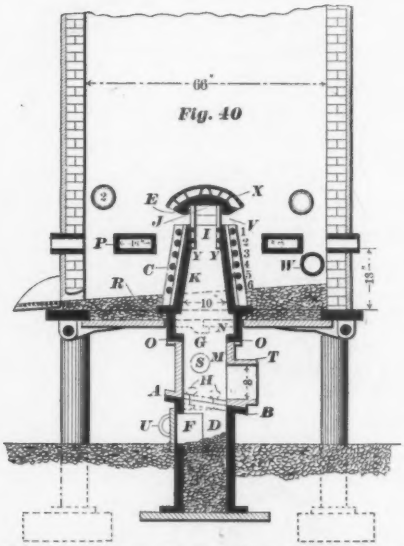


Fig. 40

West's Permanent Standing Center Blast for Large Cupolas.

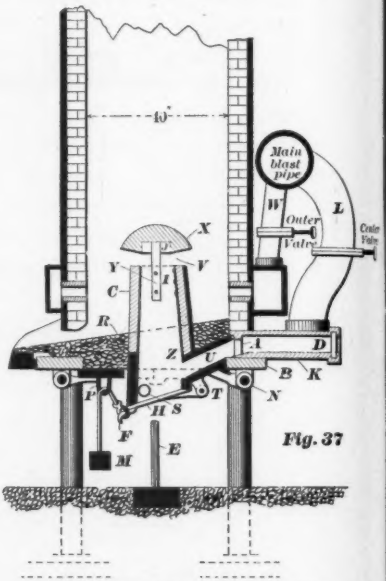


Fig. 37

West's Improved Center Blast for Small Cupolas.

trolled in the center and outside tuyeres to obtain whatever pressure in either may be thought best.

The blast area of the opening at U, Figs. 37 and 35, is to be found by dividing the area of the cupola by 30. If the cupola is 40 inches inside diameter, this gives an area of 41.89 inches, or, in rough figures, an opening 4 inches by 10 inches, and at I a diameter of about 7 inches. The width of the opening at V for the admittance of the blast to the stock in the cupola should range from

2 1-2 inches to 3 inches, the larger space being best applicable for long heats. It will be noticed that the arrangement of drop door calls for a greater height of bottom sand by two to three inches than is usually adopted in the ordinary cupola. This may be objectionable for some cupolas, but the same can be overcome by having the drop doors extend lower with a flange around the circumference to project upward to close the bottom plate of the cupola, as suggested at B B, Fig. 36, and cutting a piece out of the bottom plate at B, Fig. 37, and then strengthening the same with a wrought sheet bolted to the bottom plate.

For holding up the drop doors with props, two bars are to be used as represented at E, one to be on each side of the blast inlet circle. H is a door so hinged and held up by means of the weight, wire rope, hook and staple seen at M, P and F, that should any occasion call for its being opened suddenly to release any slag or molten metal that might, from any cause, leak down the center tuyere, it can be quickly operated without causing any stoppage or much loss in blast. S is a peep-hole to be closed with isinglass. A is a rib to make a backing for clay to tightly close the joint of the drop door in its union with the wind box K, and which should be of the same area at A for the admittance of blast as that cited for the area at U. D is a recess to admit a slide valve to close the end of the wind box K. N is one of the ear-lugs for hinging the drop doors. R is the sand bottom showing the cupola ready for its bed of fuel. C, the center tuyere, and X the covering cap. W, branch pipe for the outside tuyeres, and L for the center. The plan and section views of the drop doors seen at Figs. 35 and 36 will explain themselves.

In describing the large cupola, Fig. 40, the cap casting seen at Fig. 38 should not be less than 1 1-4 inch thick in any part, and the greatest attention paid to having the edge at R closely pricked with a double row of 1-4 inch pieces of wrought iron rods or nails, as suggested at K and A B, Fig. 38. The cap X is the only part of the tuyere requiring extra care. This is necessary in order to get it to stand the action of the fusing heat and friction of the steady downward movement of the fuel and iron when the cupola is in blast. Protect the edge R so that the clay cannot be broken

away from it, and you can then expect perfect success in utilizing center blast. The prickers C, D and E should extend about two inches high and be as thick as they can be comfortably cast on. X at Fig. 38 is a 1-2 inch hook cast in the cap to handle it by. The recess at J should be about 3 inches deep and of a diameter to admit the cap supporters, as seen at Y Y Y, Fig. 39. These supporters are made of 1 1-4 inch wrought iron bolted to the tuyere casting. It is not necessary to protect them by clay, likewise the under side of the cap at E, Fig. 40, as the cold blast keeps these points sufficiently cool to prevent them fusing or even getting very hot.

This cap should be about 4 inches larger in diameter over all than the outside of the center tuyere up at V. The center tuyere upright is made of cast iron. In the plan view at Fig. 39 are seen eight ribs cast so as to run the entire length of the tuyere, over which are placed 1-2 inch wrought iron rings, as seen at M, Fig. 39, and at the numerals 1, 2, 3, 4, 5 and 6, Fig. 40. Owing to the center tuyere being made on a taper, as shown, these rings are readily adjusted to tighten themselves. We find this method better than prickers to hold the clay and to extend the life of a tuyere to run through a large number of "heats." A 1-2 inch wrought iron or boiler plate upright tuyere could be used in place of the cast iron one shown, which is about 3-4 inch thick, and for cupolas where it was intended to drop them with the bottom, boiler plate center tuyeres would be best on account of their being lighter to handle. These upright tuyeres and covering caps are dried in their positions or in an oven before being subjected to a regular "heat."

It is to be understood that the tuyere shown with the large cupola or Fig. 40 is a permanent structure, not to be dropped with the bottom, thereby overcoming the inconvenience heretofore experienced in being compelled to erect a center tuyere at every "heat."

The recess at N, Fig. 40, is caused by reason of making that part of the diameter sufficiently large to admit of the door dropping without striking the flange through the section O O. A flange will be noticed on the center tuyere at its lower body, pro-

jecting over the drop doors. This is needed in case it might, at any time, be found necessary during a heat to move the section M. This section is seen to have one end on an incline as at the flange A and B, and on removal of the pins H H can be readily slid out from under the center tuyere, after the branch blast pipe attached to T is disconnected. In a few moments the section M can be replaced ready again for the passage of blast. At F is shown an opening level with the ground floor, at which point is also seen a door, U, which should extend fully half the way round the column, as shown, and have double doors, so that should any iron or slag for any reason chill inside of the column at its bottom it can be readily removed. The slope D at this door inside the column is formed of sand. If rough castings are used, the points at A B and O O can be bedded in soft clay to make them wind-tight. Of course these joints could be planed to save this labor, if desired.

The writer has not shown any outside blast connection or branch pipes to lead to the center tuyere projection T, Fig. 40, for the reason that there are but very few cupolas alike in their wind box and blast connections.

When first starting to use center-blast, the author thought he would have difficulty in obtaining a lining for the tuyere and covering cap that would withstand the fusing heat of the cupola. Experience has proved that any fair grade of fire clay will answer, and while it is advisable to have an extra dried tuyere and covering cap on hand, many will be surprised to learn that where center tuyeres are not dropped with the bottom, they will run for a dozen or two "heats."

The center tuyere cupola excels any other form in the saving of fuel, lining and time in melting. It also excels by reducing the wastage of iron through chillings being contaminated with the cloggings around the tuyeres and refuse of a "bottom drop." This is owing to the excess of heat at the end of a "cast." As a general thing, the longer the heat, the greater the fluidity of the metal obtained. With this center blast no fumes or gas are to be seen shooting up out of the stack at the close of a "heat."

Every now and then we hear of somebody resurrecting old designs, thinking they have something new. The author has now

special reference to the plan being advocated of drawing in a cupola above the tuyeres, making its area at the bosh thus formed about a third less than any other part of the cupola, thinking by this to attain the end gained by center blast. The bunging up due to such designs, where heats are extended to any length, long since has relegated this old design to obscurity. The writer has tried all these methods to learn just how far they could be utilized in an effort to approach center blast, but has found them of little value.

The arrangement of the designs for center blast herein described admits of a cupola being run to finish its "heat" should anything go wrong with the center tuyere. The removal of the section M, Fig. 40, or the opening of the drop door H, Fig. 37, admits of the center tuyere proper being plugged up with stiff clay so as to shut its blast off and permits a continuation of a heat by the use of the outside tuyere.

The arrangement shown in Fig. 40 has been used in the writer's foundry for the past four months with the greatest success, not only in "heats" of an hour or two, but also in "heats" of four or five hours, since we seldom melt less than 40 or 50 tons at a "heat," in the large cupola shown. It will thus be seen the center tuyere has been subjected to a very rigid test.

Briefly stated, the advantages which we find in favor of "center blast," in comparison with other methods are: 1, Reduction of fuel from one to eight to one to twelve; 2, less wear on the lining; 3, increased speed of melting; 4, less wastage of chilled iron and shot; 5, less absorption of sulphur by the iron; 6, absence of flame escaping from the stack at closing or other part of heat. The iron we melt is mostly all pig, only shop scrap being mixed in with it, and the mixture we use must not exceed .10 in phosphorus, which calls for a greater percentage in fuel than if the phosphorus was higher, owing to the greater fluidity which an increase of phosphorus can add to the metal. In charging the cupola seen at Fig. 40, we place 1,430 pounds of coke for the bed and 390 pounds between each charge of iron. On the bed we have four tons of iron and three tons between every charge of coke.

For a "heat" of 40 tons, which is as small as should be run in such a large cupola, the amount of fuel used leaves us melting 1 to 13.09. For 50 tons, 1 to 13.49. For 60 tons, 1 to 13.93. For 70 tons, which is the largest heat, we have run 1 to 13.97, and, as said before, the iron is hotter at the end than at the beginning of the "heat," and it has sufficient fluidity to run stove plate, if not detained too long in the ladle.

The writer wishes to call attention to the fact that in figuring up the ratios of fuel to iron used as ranging from one to eleven and from one to twelve, no account has been taken of the coke saved from the "bottom drop," which ranges from 300 to 400 pounds at a "heat." Did we take note of this, it would safely increase our melting ratio to read one to twelve, up to one to fourteen.

The more center blast is used intelligently the faster will it supersede all other forms of melting. Different conditions call for different designs, as the plan which proves a success for one cupola or class of work may be an utter failure for another. Each founder should judge for himself as to the best methods to be adopted in his work.

DISCUSSION.

Mr. W. N. Moore:—I have had no experience in center blast cupolas. I do not know how much I might have had if I had not found some other people were putting them on the market and waited to see what the result would be. That is about all the information I possess, and I guess everybody has that. The Foundry Outfitting Co. has a center blast cupola on the market and we were disposed to try it.

Mr. West's letter of explanation as to the way in which he came to make an error in getting his coke consumption, seems to me to rather weaken his assertion of the remarkable results he obtained. Without being in a position to criticize or say that Mr. West does not get these results, because we have to take his statement as it stands, it is evident that he is depending upon "forkfuls" of coke. Mr. West corrects his result and says that 13 to 1 is too low. I think there is only one way to determine the amount of coke consumed in the cupola, and that is to weigh every pound of coke as

it goes up on the scaffold. I think the weight of Mr. West's argument would be very much greater if he were able to state that the record of the coke had been accurately kept. I think his paper would be stronger if his letter of explanation had not been made. However, the subject is a very interesting one, and whether Mr. West is consuming 12 to 1, or 10 to 1, he is evidently satisfied that he is getting very much better results. I think it is a subject that will bear investigation. Several of his propositions seem to be reasonable.

Mr. A. W. McArthur:—It is very much to be regretted that Mr. West does not give a great many of his facts in much more exact shape. In his little experiment of going into the cupola with a handkerchief there is not enough definitiveness about it to make it at all valuable to me personally, and I do not see how it can be to anybody. I think that if he had held his handkerchief a foot away from the tuyere opening he would have found a very decided current of air.

Mr. Ferguson:—I never had any experience, either experimentally or practically, with center blast tuyeres. I have thought for some time past that it was the proper thing to do with a cupola. I am much pleased with Mr. West's paper and explanation of the work he has put upon the thing. As to the results that he is getting, I think that they are a little visionary. I am skeptical of these results on account of experience I have had with other patented cupolas that have claimed economy and, up to date, I have not found any of them more economical than other cupolas. The objection I have always found to a center blast was taking care of it. The amount of labor there would be in taking care of it would overbalance any benefit that might be derived from its use. The only way to get at this thing is to go at it and see what can be done. He states the thing very clearly, and probably if foundrymen would take hold of it they could help him perfect it.

Mr. Pettigrew:—I have never had any experience with center blasts. I think, if any foundryman will go into an empty cupola he will find the experience of Mr. West just as he states it. But let him put a charge on—say enough to make a bed for the heat—

and then go in and try his handkerchief experiment and see what it will be. I think he will find that the diffusion of the blast through the cupola is pretty even. It will diffuse itself through the fuel in pretty uniform ratio. The slag and iron will stay right around the tuyeres, caused by the chilling of the blast then we have got to have a center blast to melt the iron, and you will find after a large heat, if you have a clean drop, that the center will drop clean on account of the excess of heat being in the center. My idea has always been to have a hot blast for the cupola. My ideas have always run more to having an arrangement of tuyeres something like a blast furnace. By this arrangement of tuyeres you would find, with the warm blast up to 300 degrees or 400 degrees there will be a great saving in foundry practice.

Mr. Moore:—I am right in line with Mr. Pettigrew in regard to what he says about heating the blast. I would like to ask the Secretary, who I believe figures on these things once in a while, whether there are any figures to show the amount of heat units or coke that is used in heating the air from its normal temperature up to say 500 degrees, or to a point that possibly can be gained by the use of reheating appliances which are used to heat blast furnaces.

Mr. Sorge:—I have made such estimates, Mr. Moore, but unfortunately, I have not them with me. I cannot give the figures. It is not a very difficult thing to determine. I went into that subject not very long ago in looking over a foundry and I found that if about 25 per cent of the heat which usually escapes from the top of the cupola—that is, that heat which is produced by combustion —were used for heating the blast, that the temperature of the air could be raised up to the vicinity of 450 degrees—that is, assuming the melting capacity of the cupola to be eight of iron to one of coke. By means of this heating of the air the melting capacity would be at the ratio of one to 14.

Mr. Moore:—The theoretical consumption of fuel to iron would be about what?

Mr. Sorge:—About one to 32 and the actual is about one to eight—that is, on the average daily run. By saving 25 per cent of

the heat that usually goes out of the stack, and this can be done without any difficulty, I think will bring the ratio from one to eight up to one to 14.

Mr. Ferguson:—How do you account for that rapid increase in the ratio when you only estimated one-fourth of the heat as wasted?

Mr. Sorge:—I account for it in that three-quarters of the total heat is wasted originally.

Mr. Ferguson:—How can you increase that 1 to 8 to 1 to 14?

Mr. Sorge:—You are losing at least 75 per cent to 80 per cent at present in the stack. If you could save about 25 per cent of what you are losing in the stack, which I think can be done very readily, you can raise it to 1 to 14. In heating up to a temperature of this kind, say 400 degrees or 500 degrees, no special cooling apparatus is needed. In a blast furnace they run the heat up 1,100 degrees or 1,400 degrees, but in a cupola I would not use more than 450 degrees to 500 degrees.

Mr. Carver:—I note that Mr. Sorge states that he considers it very good foundry practice in cupola melting to obtain a melt of eight lbs. of iron to one of coke. It seems to me that the ordinary owners of foundries would consider it very poor practice if their foreman or superintendent did not obtain better results. I do not understand how Mr. Sorge makes out as extremely good foundry practice to melt eight lbs. of iron to one of coke.

Mr. Sorge: I did not say it was extremely good foundry practice. I said it was ordinarily good foundry practice. I think that if you will go through the foundries in the country and get their actual weights of iron and coke you will find that it is good foundry practice. I have melted 12 to 1, and I can do it again, but I have yet to find the practice the year round with a correct record —actually weighing every pound of coke going on the platform and every pound of iron going on the platform—to exceed 1 to 8. That is my position in the matter.

Mr. Thompson:—I do not think the paper has gone far enough to give us an idea whether this is economical melting or not.

While Mr. West claims to show a saving of fuel it would have been better if he had shown the cost of repairs.

Mr. Carver:—It is a question whether, in actual practice, the blast around the outside of the heat would not tend to bring the temperature of the central part of the heat higher than if the blast were confined to the center and expected to radiate heat to the outer edges of the cupola? Now, for instance, you take an ordinary coal fire in a stove. You have no difficulty in the burning of the fuel in the central part of the fire. If there is any dead coal anywhere it is usually around the outer edges of the stove and the lining. I bring this question up to know whether or not the present diffusion of air through the tuyeres from the outside does not give better results on account of the better distribution of the air than if confined to a central location.

Mr. McArthur:—Mr. West's whole contention is that with tuyeres on the outside of the cupola instead of in the center of the cupola, the blast does not penetrate to the center of the charge.

Mr. Pettigrew:—I do not hold that opinion at all. I think the first remarks I made would show that the center is always the hottest part of the cupola. Any one that has noticed a cupola dropped will always see—it does not matter how much chilled iron there may be on the outside—that the center will always drop clean, evidently showing that the hottest part is right in the center of the cupola. That is the point I tried to make. I am sure it will hold good in any cupola. Mr. West places his blast both outside and in the center.

Mr. Moore:—I made an experiment some years ago. The idea was that the outside of the cupola was cooler than the center, as shown by the bridging of the outside, therefore the iron should be in the center. Working on that idea I went up on the charging floor one day and, much against the advice of the wise-acres, I worked the charge having the iron pretty much in the center and the fuel pretty much on the outside. I presume there are others that have worked on this and have had the same result. If there are those that have not, I would not advise them to do it. If there was not a strong tendency in the ordinary cupola to drive heat

from the outside toward the center an experiment such as I tried would not have been failure.

Mr. Gibbs:—My experience in charging iron in the cupola is to make the fuel and iron as even as possible. Put on your coke even and your iron in the same way. I have always found it to melt better in that way. As far as 8 to 1 is concerned, I think that is pretty good cupola practice.

Mr. Stantial:—I should like to ask some questions in regard to the utilization of the heat in the top of the cupola. I would like to know if any of the members have made any experiments in that line. I have in mind one experiment that was made. A foundryman made up his mind that the waste heat could be utilized and he put his boilers on the top of his cupola, but it was a rank failure.

Mr. Moore:—The utilization of waste heat in the cupola is one that the Bessemer steel men are in a position to solve and their interest in the matter is greater than any one else's. They have cupolas that work day in and day out for a week at a time, and yet, for some reason, although they spend thousands of dollars—I think the ratio is $3,000 expenditure for the saving of one cent a ton on product—they have not investigated it. Whether it is one of the things they have overlooked, or whether any one has gone into the subject thoroughly enough to demonstrate that it is impracticable, I do not know. I have asked some of the engineers in connection with steel works why they did not abandon their cupolas and put in a miniature blast furnace and run it, but I have not got a satisfactory answer. The thing has never been done. There seems to be a difference of opinion as to its practicability. Some have told me that the lining could not stand and others have not given any good reason. There is the place where the circumstances are favorable and I think we must look to the steel people to bring out the utilization of waste heat.

Mr. Stantial:—In cupolas of the present day it is generally the custom to make the tuyeres so that the entrance from the blast pipe is reduced and the tuyeres passing through the lining are broadened out so that the areas of the tuyeres where the air passes

into the cupola is something like twice the area of the tuyere where the air enters it. I would like to know why there is any advantage in this or why it should not be the other way.

Mr. Vrooman:—The air when it strikes the tuyeres will spread out. If they were pointed it would not.

Mr. Pettigrew:—I know of a cupola that had a direct pipe 12 inches in diameter right into the cupola and did good melting. One tuyere without any blast box at all.

Mr. Sorge:—If you would introduce a very intense blast at one point you would produce a very high temperature and burn out your fuel at that point and burn holes right through. I believe the idea is that of diffusing the blast and reducing its intensity at the point where it comes in contact with the fuel.

Mr. Ferguson:—I am aware that that point is claimed by the designers of cupolas, but in my own practice I have not found it so. I can recall a furnace of 36-inch diameter that ran with its four or five inch tuyeres direct, each one leading to the center of the furnace, and for speedy melting I have not seen anything yet that surpassed it. As for the lining of the furnace, I can state that I was in the shop for three years and that the furnace was not relined at the melting point or any other portion. I was told that it had not been relined for four years previous to my going there.

Mr. Dalton:—I have a furnace that is very similar to that, and it is very easy on the lining. We have not lined it for two years and it is just in shape to be lined now.

Mr. Moore:—I think in speaking of the duration of the lining of a cupola, the amount of brick used for patching should be taken into consideration. We ran a cupola for about a year and it got where it ought to be relined. It was not convenient to do it, and we ran it pretty nearly another year and did not reline it, but I think that if we had relined it when it needed relining, we would have saved in brick enough to make us come out even. It is sometimes the case that when a cupola is run for a long time without relining as much brick is used for patching as would have been for relining, if not more. I have a record of a long-running cupola, but I do not know how many bricks were used to keep it in order, but I know there were a great many.

TOPICAL QUESTIONS.

On motion, the editing committee was requested to put this matter of center-blast cupola on the list of topical questions, to be discussed in its order.

On motion, it was decided to take up topical question No. 6 for discussion. It reads as follows:

"In your experience, what is the most efficient method of cleaning light castings?"

Mr. Sorge:—I would like to state for the information of the association that I am anticipating getting a paper on sand-blast from Ward & Nash, and I am also trying to get another from F. A. Goodrich & Co., of Detroit. It seems to me the sand-blast will be taken up most satisfactorily by these gentlemen who make a specialty of it.

Topical question No. 7 was read as follows: "What is the proper temperature at which to bake cores? What method do you use for determining this temperature?"

Mr. Stantial:—On our small cores we use steam and it takes a great deal longer to dry them than it does with the fire oven, but we can give them time. We are making them continuously during the day and have relays of ovens.

Mr. Lukens:—Our ovens are constructed with shelves. I put the thermometer in and left it five minutes. A two-inch core was dried in 1 1-2 minutes and the temperature went up to 275 degrees. When it was cooled it was fit to use in the mold.

Mr. Pettigrew:—Since joining the Western Foundrymen's Association I have gone around among the foundries more than I have before, especially in Chicago. In visiting the Sargent Co.'s works I found that to be the only place where oil was introduced in the core oven or ovens of any kind. I would advise all the members of the association to visit these works. It is a clean heat and a good deal cheaper in the drying of both cores and molds.

Mr. McArthur:—Did you see any device that would indicate the temperature of the oven?

Mr. Pettigrew:—No. They can tell after a certain amount of experience. In Pittsburg last year I noticed that the foundries all used natural gas, but they used it through a bed of small coke. They put a bed of coke on the fire and introduced the gas below that. It is clean and quick.

Mr. McArthur:—Is this oil flame in the oven at the Sargent Co.' works?

Mr. Pettigrew:—Right in the oven without any bridge wall.

Mr. Sorge:—How many burners have they?

Mr. Pettigrew:—Two in each oven.

Mr. McArthur:—It seems to me that the matter of core ovens is too large a subject to be dismissed. I think it is worthy of the special investigation of a committee to report two or three meetings hence after collecting all the possible information.

On motion, the President was authorized to appoint a committee of three members to investigate the matter and make a report at the next meeting as to the best methods of heating core ovens, the regulating of them and the proper temperature at which to bake cores.

The meeting then adjourned.

THE PHILADELPHIA FOUNDRYMEN'S ASSOCIATION.

The regular monthly meeting of the Philadelphia Foundrymen's Association was held at the Manufacturers' Club, in Philadelphia, on Wednesday, June 3, the president, Francis Schumann, occupying the chair.

The treasurer presented a report dealing mainly with the expenses of the late convention of foundrymen, and Secretary Evans, in a brief verbal report, outlined the part in the affair taken by the association.

W. T. Rainey, of W. T. Rainey & Co., Philadelphia, then addressed the meeting on the subject of

"THE MANUFACTURE OF COKE AND ITS SELECTION FOR THE FOUNDRY."

He said: "There are several districts in this country where coke is made. The largest district is Connellsville, Pa. The mountain districts of Pennsylvania, West Virginia and a few other States are also coming into the market with cokes. The quality of coke depends upon the coal from which it is made. It is absolutely necessary that a good quality of coal should be used. It is not, however, necessary that a first quality of commercial coal be used, Connellsville coal, for instance, being little used except for the manufacture of coke. The coal mentioned is so full of volatile matter that it does not make a good steam coal, and when used for that purpose clinkers and clogs grate bars. After the coal is mined the process of coking is much about the same as adopted in all parts of this country. The coal is brought to the ovens in wagons or carts called "lorries," which discharge their contents, by means of a shute, into the ovens. The charge is about 6 tons of coal. After charging, the door is bricked up and covered with clay. The heat retained from the previous charge, and also obtained from the alternate ovens, which are in full blast, causes the distillation of gases, and these gases pass off

through the top of the oven. The coal is allowed to bake in the oven for 48 hours, and at the end of that time the mass is thoroughly coked. The finished condition is easily ascertained by looking into the oven over the top of the door. A man then takes a long hooked pole and tears down the clay and brick from the door. This done, he inserts a piece of gas pipe attached to a hose and plays water on the fire until it is quenched. The coke is then allowed to stand until the water is all driven off as steam. After the oven has been watered and the coke allowed to dry, the coke is drawn out with a scraper, a long iron bar with a hook on its end. It is then forked into wheelbarrows and wheeled across the yard, where it is loaded into cars.

"The method of charging the ovens is as follows: An oven is charged to-day and will be ready for drawing the day after to-morrow. For instance, an oven charged on Monday would be ready to draw on Wednesday; an oven charged on Tuesday would be drawn on Thursday; an oven charged on Friday must necessarily go over to Monday, and that is when 72-hour coke results. After drawing, the heat is kept in the ovens to help ignition on recharging. The fuel begins to burn and the coal starts to coke from the top downward. This is proved by the fact that if an oven charged to-day was by accident drawn to-morrow, a charge of coal would be found in the bottom. If the oven is allowed to stand without the coke being taken out it is soon consumed, and burns to ashes from the top of the charge downward. Seventy-two hour coke is always made when there is one day laid off between charge and drawing. A Friday or Saturday oven is therefore increased in charge, which entails a longer burning. A great many foundrymen have the idea that they can distinguish the difference between 48 and 72 hour coke. Now, I do not think any one living can tell the difference. I cannot.

"The Connellsville coke is distinctive, owing to its firm structure and porosity, and the structure, looking at the end of the piece, is flaky, making a hard breaking coke. There is a distinct ringing sound produced by striking two pieces together. It is these qualities which cause it to be considered superior for blast

furnace use where the furnaces are built high. If the coke is not strong and hard it will be crushed down and thus entail difficulty in getting the blast of air through it. Very often a foundryman prefers coke having a silver luster on it. Such coke certainly is beautiful, but I have never seen coke silvery on the outside but what was black inside. When coal is properly coked there will always be a little raw coal in the bottom of the oven, which sticks to the coke. If there is no coal on the bottom of the charge the chances are that the whole charge will run high in ash, as the coke begins to burn up as soon as the coking process closes.

"In looking at a car of coke and seeing a little coal on the bottom, it is no indication that it is not properly coked. The piece of coke which comes from the front of the oven will always be a little spongy, sometimes very much so. This cannot be helped. Oven doors will leak a little, and curly and spongy coke near the door results. Perhaps there will be two to three wheelbarrow loads of that sort. The best coke comes from the heart of the oven. In furnace coke everything that comes out of the oven is loaded in the car. Foundry coke is selected, spongy coke and anything that may not look nice and bright being discarded, and that is the reason foundrymen pay more for their coke. Foundry coke is nearly always loaded in box cars, and this, too, adds to the cost. The slats in the door of the car and the packing against them is also an additional expense. The placing of large pieces of coke in the door makes the coke look nicer, and a careless arrangement often leads to a car of really first-class coke being refused.

"There is another coking process used a great deal in Europe —a by product process by which the gases are saved from going to waste, and tar and ammonia extracted, the gas then being used for other purposes. The process is not used to any extent in this country, Johnstown, Dunbar and Syracuse having the principal plants. The coke made by the by-product process is different from the ordinary coke. The ovens are built 18, 20 and 25 feet long, and in parallel rows. They are closed up absolutely tight and have flues all around them, through which the gases pass. The coal is heated, but no flame is allowed to come in contact

with it. The gases pass out of the oven, and after the tar and ammonia have been extracted from them part of the gases are brought back and burned under the ovens. This process makes a dense and very heavy coke.

"Coke from the West Virginia fields is usually a little more silvery than Connellsville, and denser, as you will see by a sample before you."

Asked whether the specific gravity in 72-hour coke was not greater than in 48-hour coke, Mr .Rainey replied: "No, it is not. If you bake a little loaf of bread beside a larger one, the larger one will take longer to bake through, but the result will be the same. It is the same with coke. A hard and clean coke that does not run too high in sulphur is best for foundry use. It should be fairly strong. What is known as 'mountain' coke differs in structure from the Connellsville coke. It is more open and porous and lighter, crushes down quicker, and is not a good furnace fuel for modern high stacks."

Asked what is the average ash in Connellsville coke Mr. Rainey answered: "It runs from 8 to 10 per cent and varies." Continuing, he said: "The weather has some effect on coke, and exposure alters its appearance somewhat. Some people believe that laying coke out in the weather, even a little, injures it. I think this is a mistake. We once found some discarded coke which had been lying exposed to weather for nearly 20 years. When good coke was scarce we brought this old coke to the notice of a customer and he used it and pronounced it the best he had ever used. When coke is exposed the sulphur may work out, leaving a stain of iron which mars the appearance of the coke. The best Connellsville coke should not run over 3-4 to 1 per cent of sulphur. The coke region is 50 miles long and 1 to 3 miles wide, and the quality of the coal varies. If you go to the north of the district the coal is slaty and makes slaty coke. As you go south it improves until the neighborhood of Connellsville is reached. Further south it begins to increase in slate and runs high in sulphur."

The meeting then adjourned with the understanding that the next meeting would be held in September, thus abandoning meetings during the hot season.

A REVIEW OF THE FOUNDRY LITERATURE OF THE MONTH.

It is intended to make the following department of this Journal a most valuable feature and subsequent issues will show it much enlarged and improved.

It will contain, from time to time, a brief review or mention of the original articles appearing in the columns of the trade press of the country having reference to the foundry business.

AMERICAN MACHINIST.

JUNE 4.—E. Grindrod asks some questions on the subject of chilling cast iron, thickness of chill, kind of iron most suitable, etc., and is replied to by L. C. Jewett, who, in a lengthy and interesting letter in which authorities are quoted, gives many valuable pointers as to how to obtain generally best results.

JUNE 11.—John Randol has a two-page article with six illustrations on molding machines for foundry purposes, having special reference to the manufacture of reaper frames as made at the works of the Milwaukee Harvester Company.

JUNE 18.—John Randol has an interesting article with three illustrations describing the explosion of a hollow brass casting while it was being melted in a Brooklyn brass foundry. The photograph gives interior views of the foundry, showing damage done, view of pieces of casting as well as sketch of plunger as it looked before the explosion.

S. M. Rushmore has a letter on the subject of protecting wooden patterns.

J. C. Green has an article on cupola charging.

George O. Vair describes a method of molding brass tuyeres, giving several illustrations.

L. C. Jewett describes and illustrates a cheap "trip" for suspending weights used for breaking old scrap or castings.

JUNE 25.=This number contains two letters, one from N. Portz and one from Wm. Viggers, on the subject of charging

cupolas. It also illustrates and describes a large cast steel gear wheel recently made at a well-known steel foundry.

Newell Sanders has an illustration and description of a Mexican cupola.

DIGEST OF PHYSICAL TESTS.

JULY.—Wilfred Lewis writes commending the elaborate series of experiments made by A. E. Outerbridge to determine the "Mobility of the Molecules of Cast Iron." Mr. Outerbridge also contributes a letter and a criticism is submitted by the editor throwing more light on this very interesting question.

IRON MOLDERS' JOURNAL.

JUNE.—Robert Watson writes entertainingly and furnishes illustration of a method adopted at one time to pour a heavy casting direct from a cupola without the use of crane ladle.

Another contributor furnishes illustration and describes a method adopted in a large English foundry to cast a peculiar shaped column weighing over seven tons.

IRON TRADE REVIEW.

JUNE 4.—Thomas D. West writes concerning the grading of pig iron at a blast furnace and various methods of having analyses made of different casts in order to secure nniform results. He also suggests a plan for mixing and piling the pigs as taken from blast furnace that would be likely to add to this uniformity.

MACHINERY.

JUNE, 1896.—E. W. Kelly has an article with two illustrations concerning the best method for making a core box for a rather difficult piece of work resembling a globe valve.

RAILWAY AGE.

JUNE 22.—This issue contains a report of a committee appointed by the Master Car Builders' Association to make a series of tests at various speeds of different kinds of brake shoes submitted by various manufacturers for that purpose. The re-

port occupies four pages, is profusely illustrated with diagrams, and to foundrymen interested in railway work it should be very interesting.

THE FOUNDRY.

JUNE, 1896.—W. J. Keep contributes under his regular column of Cast Iron Notes some comments on the subject of the grading of pig iron.

George Busch, N. Portz and the Warren Foundry & Machine Company have letters on the subject of cupola charging.

A. Sorge, Jr., and James A. Beckett have letters on the subject of "The Effect of Atmospheric Temperature and Humidity of Melting Iron in a Cupola."

THE IRON AGE.

JUNE 18.—A. Sorge Jr., M. E., has a lengthy article on the subject of Pattern Shop Costs, giving in detail a system worked out by himself for keeping track of this important matter, and which contains reproductions of the various sheets and forms used. The article covers seven pages and is probably the most elaborate paper yet drawn up on that subject.

ACTIVE MEMBERS.

June 25, 1896—Abendroth Bros.....Port Chester, N. Y.
July 9, 1896—Aermotor Co.....12th, Rockwell & Fillmore, Chicago, Ill.
July 17, 1896—American Radiator Co.....Detroit, Mich.
June 29, 1896—Amsden, Alonzo D.,.....Phoenix Foundry, Providence, R. I.
July 10, 1896—Barbour-Stockwell Co.....205 Broadway, Cambridgeport, Mass.
July 22, 1896—Babington, B. B.....B. B. Babington, Son & Co., Shelby, N. C.
June 17, 1896—Beckett, James A...W. A. Wood Mowing & Reaping Co., Hoosick Falls, N. Y.
June 28, 1896—Blackburn, A. H..... Fuel Economizer Co., Matteawan, N. Y.
July 13, 1896—Buffalo Forge Co.....Buffalo, N. Y.
July 20, 1896—Carpenter, A. & Sons,.....272 W. Exchange, Providence, R. I.
June 27, 1896—Cavanaugh, Francis.....Quakertown Stove Works, Quakertown, Pa.
June 11, 1896—Campbell, Twining.....Paterson, N. J.
June 29, 1896—S. Cheney & Son.....Manlius, N. Y.
June 23, 1896—Chas. N. Choate..Bridgeport, Deox., Bronze & Metal Co., Bridgeport, Conn.
June 16, 1896—Colvin, Theo. H.....Theo. H. Colvin Foundry Co., Providence, R. I.
July 21, 1896—Colorado Fuel & Iron Co.....Pueblo, Col.
July 1, 1896—Connersville Blower Co.....Connersville, Ind.
July 11, 1896—Condor Iron Foundry Co.....East Boston, Mass.
June 26, 1896—Co-operative Foundry Co.....15 Hill St., Rochester, N. Y.
June 24, 1896—Corbin, P. & F.....New Britain, Conn.
Aug. 28, 1896—The Carnegie Steel Co.....Pittsburg, Pa.
June 29, 1896—Davis Foundry Co.....Lawrence, Mass.
July 18, 1896—Day, F. M.....Hopedale Machine Co., Hopedale, Mass.
Aug. 24, 1896—Dickson Mfg. Co.....Scranton, Pa.
June 22, 1896—Dighton Furnace Co.....Taunton, Mass.
June 29, 1896—Donaldson, J. F.....Ingersoll-Sergeant Drill Co., 640 Wolf St., Easton, Pa.
June 19, 1896—Drummond Mfg. Co.....Louisville, Ky.
Sept. 7, 1896—Dry Dock Engine Works.....Detroit, Mich.
Aug. 26, 1896—Erie Malleable Iron Co., Ltd.....Erie, Pa.

July 1, 1896—Evans, Henry Clay. Mgr. Chattanooga Car & Fdy. Co., Chattanooga, Tenn.
June 28, 1896—Fisher, John E... Foreman Foundry, National Transit Co., Oil City, Pa.
July 1, 1896—Flagg, Stanley G. & Co... 19th and Pennnsylvania ave.,
Aug. 29, 1896—Flather, Frederick A..... Lowell Machine Shop, Lowell, Mass.
Philadelphia, Pa.
June 25, 1896—Frank-Kneeland Machine Co..... 54th St., Pittsburg, Pa.
June 18, 1896—Gibby, F. W..... Prest. Mechanics' Iron Fdy. Co., 38 Kemble St., Roxbury, Mass.
July 11, 1896—Gillette-Herzog Mfg. Co..... Minneapolis, Minn.
July 1, 1896—Girard Iron Works..... 22d & Master, Philadelphia, Pa.
July 5, 1896—Groves, S..... Taylor, Wilson & Co., Allegheny, Pa.
July 19, 1896—Hanson, Wm..... 5404 Lancaster ave., Philadelphia, Pennsylvania Iron Works Co., Philadelphia, Pa.
July 2, 1896—Hubley Mfg. Co., ... Lancaster, Pa.
Aug. 26, 1896—Samuel F. Hodge & Co..... Detroit, Mich.
July 2, 1896—Ingersoll-Sergeant Drill Co..... Havemeyer Bldg., New York, N. Y.
June 29, 1896—Jarecki Mfg. Co., Ltd., Foundry Dept..... Erie, Pa.
July 30, 1896—James, Geo..... Mangr. Variety Iron Works, Seattle, Wash.
July 23, 1896—Jobb, Chas. L..... Londonderry Iron Co., Londonderry, N. S.
Sept. 2, 1896—Jones, E. H..... 143 S. Franklin St., Wilkes-Barre, Pa.
June 18, 1896—Keep, Wm. J..... Supt. Michigan Stove. Co., 753 Jefferson Ave., Detroit, Mich.
June 22, 1896—Kimball, W. G..... S. G. Kimball's Sons, 127 Washington St., Newburgh, N. Y.
July 14, 1896—Kittanning Iron & Steel Mfg. Co..... Kittanning, Pa.
June 29, 1896—Kitchell, H. G..... Delta Machine Co., Greenwood, Miss.
June 29, 1896—Knoeppel, John C... Foreman Foundry Buffalo Forge Co., 540 Swan St., Buffalo, N. Y.
June 29, 1896—Koken, Wm. T..... Koken Iron Works, St. Louis, Mo.
July 9, 1896—Koons, Jos..... With L. V. R. R. Co., Weatherly, Pa.
June 16, 1896—Lane Mfg. Co..... Montpelier, Vt.
June 27, 1896—Leechburg Fdy. & Mach. Co..... Lewis Blk., Pittsburg, Pa.
July 4, 1896—LeBaron Foundry Co..... Middleborough, Mass.

Sept. 2, 1896—Letchworth, O. P.....Pres. Pratt & Letchworth Co., Buffalo, N. Y.
June 29, 1896—Lincoln, Geo. H. & Co.....South Boston, Mass.
July 11, 1896—Little, Owen J..Propr. Deckertown Foundry and Machine Shops, Deckertown, N. J.
June 19, 1896—Lutterman, T. F. A.....Foreman National Supply Co., 1422 Baxter St., Auburndale, O.
June 18, 1896—Magee Furnace Co.....Boston, Mass.
July 28, 1896—Maher & Flockhart.....Newark, N. J.
July 3, 1896—Malleable Iron Fittings Co.....Brandford, Conn.
July 13, 1896—Mathes, Ph.....Brittan, Graham & Mathes Co., 411 Wood St., Pittsburg, Pa.
Aug. 27, 1896—Matlack, David J.....2247 Richmond St., Philadelphia, Pa.
Aug. 26, 1896—The Michigan Stove Co.....Detroit, Mich.
Aug. 31, 1896—Moore, D. G.,....Pres. The S. L. Moore & Sons Co., Elizabeth, N. J.
June 29, 1896—Morris & Barlow.....28 Orange St., Newark, N. J.
June 29, 1896—Morris, Wheeler & Co.,.....16th and Market Sts., Philadelphia, Pa.
July 8, 1896—Mosher Mfg. Co.....Dallas, Tex.
July 10, 1896—Newburgh Ice Mch. & Eng. Co...Edgar Penney, Pres., Newburgh, N. Y.
June 23, 1896—Nicholas, W. H.....Foreman of Foundry P. R. R., Renova, Pa.
July 20, 1896—Northwestern Malleable Iron Co.....Milwaukee, Wis.
Aug. 12, 1896—Olympic Iron Works.....Tacoma, Wash.
July 18, 1896—Oliphant, Richard C...Pres. Trenton Malleable Iron Co., Trenton, N. J.
Aug. 26, 1896—D. M. Osborne & Co.....Auburn, N. Y.
June 25, 1896—Osgood & Hart....3 Sherman St., Charlestown Dist., Boston, Mass.
July 10, 1896—Patterson, Wm. E..Brown & Patterson, 33 Marcy Ave., Brooklyn, N. Y.
June 19, 1896—Penton, John A.....Editor "Foundry," Detroit, Mich.
July 15, 1896—Pratt & Whitney Co.....Hartford, Conn.
July 10, 1896—Ridgway, Craig & Son.....Coatesville, Pa.
July 18, 1896—Riehl, Wm.....Nat. Fdy. & Mach. Co., Louisville, Ky.
June 19, 1896—Robinson-Rea Mfg. Co.....329 Water St., Pittsburg, Pa.
July 26, 1896—Rock Run Iron & Mining Co.....Rock Run, Ala.
June 19, 1896—Rohland, John....Supt. Coxe Iron Mfg. Co., Drifton, Pa.
July 8, 1896—Roots, P. H. & F. M., Co.....Connersville, Ind.
June 26, 1896—Russell & Erwin Mfg. Co.....New Britain, Conn.
June 17, 1896—Russel, John R.....Sec'y. Russel Wheel & Fdy. Co., Detroit, Mich.
Sept. 7, 1896—Sawyer, James C.....Somersworth Machine Co., Dover, N. H.

June 17, 1896—Schumann, Francis..Pres't. Tacony Iron & Metal Co., Tacony, Pa.
June 27, 1896—Seaman-Sleeth Co.....41st St. and Willow, Pittsburg, Pa.
Aug. 31, 1896—Wm. Sellers & Co.....Philadelphia, Pa.
Sept. 5, 1896—Sessions, W. E..Gen Mgr. The Sessions Foundry Co., Bristol, Conn.
Sept. 5, 1896—Shepard, W. T.....Sec'y The Sessions Foundry Co., Bristol, Conn.
June 25, 1896—Sheppard, Isaac A. & Co.....Philadelphia, Pa.
June 29, 1896—Shickle, Harrison & Howard Iron Co.....St. Louis, Mo.
June 24, 1896—Sleeth, S. D.....Westinghouse Air Brake Co., Pittsburg, Pa.
July 1, 1896—Smith, Pemberton.....N. Y. Car Wheel Works, Buffalo, N. Y.
June 17, 1896—Sorge, A. Jr.....1533 Marquette Bldg., Chicago, Ill.
July 15, 1896—Springer, Jos. H.....Supt. Mich. Brass & Iron Works, Detroit, Mich.
July 13, 1896—St. Paul Foundry Co.....St. Paul, Minn.
Aug. 29, 1896—Stevens, W. W.....9th and Montgomery ave., Philadelphia, Pa.
July 15, 1896—Sweeney, John M...Pres't. Consolidated Iron & Steel Co., Harvey, Ill.
June 1, 1896—Syracuse Chilled Plow Co..... ..Syracuse, N. Y.
July 13, 1896—Taft, C. A.....Whitin Machine Co., Whitinsville, Mass.
June 17, 1896—Taylor, Robt.....Chairman Taylor-Wilson & Co., Allegheny, Pa.
June 17, 1896—Taylor-Wilson & Co., Ltd.....Allegheny, Pa.
July 8, 1896—Thompson, Josiah....J. Thompson & Co., Philadelphia, Pa.
July 14, 1896—Timmis & Clissold.....Bound Brook, N. J.
Aug. 26, 1896—Torrance Iron Co.....Troy, N. Y.
June 27, 1896—Treat, C. A., Mfg. Co.....Hannibal, Mo.
July 8, 1896—Walker & Pratt Mfg. Co.....Watertown, Mass.
July 20, 1896—Wallis, Philip.....M. M.; L. V. R. R., Hazelton, Pa.
June 19, 1896—Warden, King & Son.....Montreal, P. Q
June 17, 1896—Waterbury-Farrell Foundry & Machine Co., Waterbury, Conn.
July 13, 1896—Watson, James....Otis Bros. & Co., 61 Hudson St., Yonkers, N. Y.
June 27, 1896—West, Thos. D...Vice-Pres. & Mngr. Thos. D. West Foundry Co., Sharpsville, Pa.
Sept. 2, 1896—Whitney, Asa W.....1601 Callowhill St., Philadelphia, Pa.
July 3, 1896—Wilbraham-Baker Blower Co.....Philadelphia, Pa.

July 15, 1896—Wood, Walter....R. D. Wood & Co., 400 Chestnut St., Philadelphia, Pa.
Sept. 2, 1896—Worthington, Henry R.....Van Brunt St., Brooklyn, N. Y.
June 18, 1896—Yagle, Wm. & Co., Ltd.....32d St. & A. V. R. R., Pittsburg, Pa.

ASSOCIATE MEMBERS.

July 31, 1896—Andrews Bros.' Co.....Mnfrs. of Pig Iron Youngstown, O.
July 12, 1896—Burget, R. A....Treas. and Gen. Mgr. Richmond Iron Works, Richmond Furnace, Mass.
June 29, 1896—Jos. Dixon Crucible Co...Mfrs. Crucibles and Foundry Facings, Jersey City, N. J.
July 8, 1896—Findley, A. I.....Editor "Iron Trade Review" Cleveland, O.
Aug. 7. 1896—Garden City Sand Co..Molding Sand and Fire Brick, Chicago, Ill.
June 17, 1896—Goodrich, F. A. & Co.....Pig Iron Dealers 926 Chamber of Commerce, Detroit, Mich.
July, 1896—Gobeille Pattern Co.....Mfrs. of Patterns, Cleveland, O.
July 11, 1896—Hanson & Van Winkle Co..Mnfrs. of Foundry Nickel Plating Outfits, Newark, N. J.
July 17, 1896—Howe, Arthur W.,..Pig Iron Dealer, 420 Bourse Bldg. Philadelphia, Pa.
July 10, 1896—Hussman Crucible Co.....Mfrs. of Crucibles 810 Commercial Bldg., St. Louis, Mo.
June 16, 1896—McCormick, J. S., Co.....Foundry Supplies, Pittsburg, Pa.
July 20, 1896—McCullough & Dalzell Co.....Mfrs. of Crucibles, Pittsburg, Pa.
July 10, 1896—Miller, Alfred J.....Vice-Pres. Whitehead Bros.' Co., 42 S. Water St., Providence, R. I.
June 29, 1896—Millett Core Oven Co. ..Mfrs. of Millett Core Oven, Brightwood, Mass.
July 3, 1896—Obermayer, S., Co.....Foundry Supplies, Cincinnati, O.
July 6, 1896—Paxson, J. W. & Co.....Foundry Supplies, Philadelphia, Pa.
July 20, 1896—Pettinos, Geo. F.....Pettinos Bros., Foundry Facings, Bethlehem, Pa.
July 7, 1896—Pickands, Brown & Co...Mfrs. & Dealers of Pig Iron, Rookery Bldg., Chicago, Ill.
June 29, 1896—Pickands, Mather & Co...Mfrs. & Dealers of Pig Iron, Cleveland, O.

June 19, 1896—Rogers, Brown & Co.....Pig Iron Dealers,
New York, N. Y.
July 22, 1896—Rogers, Brown & Warner.....Pig Iron Dealers,
Bullitt Bldg., Philadelphia, Pa.
June 17, 1896—The Tabor Mfg. Co.....Mfrs. Molding Machines,
Elizabeth, N. J.
Aug. 17, 1896—Taylor & Son, Robt. J.....Mfrs. of Crucibles,
Philadelphia, Pa.
June 20, 1896—Translucent Fabric Co...Mfrs. of Translucent Fabric,
Quincy, Mass.
June 30, 1896—The Wells Light Mfg. Co.....Mfrs. of Wells Light,
44-46 Washington St., New York, N. Y.

LIST OF MEMBERS ARRANGED ALPHABETICALLY AS TO RESIDENCE.

ALABAMA.

Rock Run—Rock Run Iron & Mining Co.

COLORADO.

Pueblo—Colorado Fuel & Iron Co.

CONNECTICUT.

Brandford—Malleable Iron Fittings Co.
Bridgeport—Chas. N. Choate, Deox. Bronze & Metal Co.
Bristol—W. E. Sessions, Gen. Mgr. The Sessions Foundry Co.; W. T. Shepard, Sec'y The Sessions Foundry Co.
Hartford—Pratt & Whitney Co.
New Britain—P. & F. Corbin, Russell & Erwin Mfg. Co.
Waterbury—Waterbury-Farrell Foundry & Machine Co.

ILLINOIS.

Chicago—Aermotor Co., 12th, Rockwell & Fillmore; Pickands, Brown & Co.; Garden City Sand Co.; A. Sorge, Jr., 1533 Mar quette Bldg.
Harvey—John M. Sweeney, Pres't. Consolidated Iron & Steel Co.

INDIANA.

Connersville—The Connersville Blower Co.; P. H. & F. M. Roots Co.

KENTUCKY.

Louisville—The Drummond Mfg. Co.; Wm. Reihl, National Foundry & Machine Co.

MASSACHUSETTS.

Boston—Magee Furnace Co.; Osgood & Hart, 3 Sherman St., Charlestown Dist.
Brightwood—Millett Core Oven Co.
Cambridgeport—Barbour-Stockwell Co., 205 Broadway.
East Boston—Condor Iron Foundry Co.
Hopedale—F. M. Day, Hopedale Machine Co.
Lawrence—Davis Foundry Co.
Lowell—Frederick A. Flather, Lowell Machine Shop.

Middleborough—LeBaron Foundry Co.
Quincy—Translucent Fabric Co.
Richmond Furnace—R. A. Burget, Treas. & Gen. Mgr. Richmond Iron Works.
Roxbury—F. W. Gibby, 38 Kemble St.
South Boston—Geo. H. Lincoln & Co.
Taunton—Dighton Furnace Co.
Watertown—Walker & Pratt Mfg. Co.
Whitinsville—C. A. Taft, Whitin Machine Co.

MICHIGAN.

Detroit—American Radiator Co.; F. A. Goodrich & Co., 926 Chamber of Commerce; Wm. J. Keep, Supt. Michigan Stove Co.; John A. Penton, Editor "Foundry;" John R. Russel, Sec'y. Russel Wheel & Foundry Co.; Jos. H. Springer, Supt. Michigan Brass & Iron Works; Dry Dock Engine Works; Samuel F. Hodge & Co.; The Michigan Stove Co.; The Michigan Malleable Iron Co.; Frontier Iron Works.

MINNESOTA.

Minneapolis—Gillette-Herzog Mfg. Co.
St. Paul—St. Paul Foundry Co.

MISSISSIPPI.

Greenwood—H. G. Kitchell, Delta Machine Co.

MISSOURI.

Hannibal—C. A. Treat Mfg. Co.
St. Louis—Hussman Crucible Co.; Wm. F. Koken, Koken Iron Works.

NEW HAMPSHIRE.

Auburn—D. M. Osborne & Co.
Brooklyn—Wm. E. Patterson, 33 Marcy Ave.; Henry R. Worthington, Van Brunt St.
Co., 540 Swan St., Pemberton Smith, New York Car Wheel Works; O. P. Letchworth, Pres. Pratt & Letchworth Co.
Dover—James C. Sawyer, Somersworth, Mch. Co.
Scranton—Dickson Mfg. Co.

NEW JERSEY.

Bound Brook—Timmis & Clissold.
Deckertown—Owen J. Little, Prop. Deckertown Foundry & Machine Shops.
Elizabeth—The Tabor Mfg. Co.; D. G. Moore, Pres. The S. L. Moore & Sons' Co.
Jersey City—Jos. Dixon Crucible Co.

Newark—Hanson & Van Winkle Co.; Maher & Flockhart; Morris & Barlow, 28 Orange St.
Paterson—Twining Campbell.
Trenton—Richard C. Oliphant, Pres. Trenton Malleable Iron Co.

NEW YORK.

Brooklyn—Wm. E. Patterson, 33 Marcy Ave.
Buffalo—Buffalo Forge Co.; John C. Knoeppel, foreman Buffalo Forge Co., 540 Swan St.; Pemberton Smith, New York Car Wheel Works.
Hoosick Falls—Beckett A. James, W. A. Wood Mowing & Reaping Co.
Manlius—S. Cheney & Son.
Matteawan—A. H. Blackburn, Fuel Economizer Co.
Newburgh—W. G. Kimball, 127 Washington St.; Newburgh Ice Machine & Engine Co.
New York—Ingersoll-Sergeant Drill Co., Havemeyer Bldg.; Rogers, Brown & Co., The Wells Light Mfg. Co., 44-46 Washington St.
Port Chester—Abendroth Bros.
Rochester—Co-operative Foundry Co., 15 Hill St.
Syracuse—Syracuse Chilled Plow Co.
Troy—Torrance Iron Co.
Yonkers—James Watson, Otis Bros. & Co., 61 Hudson St.

NORTH CAROLINA.

Shelby—B. B. Babington, B. B. Babington, Son & Co.

OHIO.

Auburndale—T. F. A. Lutterman, Foreman National Supply Co., 1422 Baxter St.
Cincinnati—S. Obermayer Co.
Cleveland—A. I. Findley, Editor "Iron Trade Review;" Gobeille Pattern Co., Pickands, Mather & Co.
Youngstown—Andrews Bros.' Co., Mfrs. of Pig Iron.

PENNSYLVANIA.

Allegheny—S. Groves, Taylor, Wilson & Co.; Robert Taylor, Chairman Taylor, Wilson & Co.; Taylor, Wilson & Co., Ltd.
Bethlehem—Geo. F. Pettinos.
Coatesville—Craig-Ridgway & Son.
Drifton—John Rohland, Supt. Coxe Iron Mfg. Co.
Easton—J. F. Donaldson, 640 Wolf St.
Erie—Jarecki Mfg. Co., Ltd.; Erie Malleable Iron Co., Ltd., Box 485.
Hazelton—Philip Wallis, M. M.; L. V. R. R.
Kittanning—Kittanning Iron & Steel Mfg. Co.
Lancaster—Hubley Mfg. Co.
Oil City—John E. Fisher, Foreman Foundry, National Transit Co.

Pittsburg—Frank-Kneeland Machine Co., 54th st.; Leechburg Foundry & Machine Co.; Ph. Mathes, 411 Wood St., Brittan, Graham & Mathes Co.; J. S. McCormick Co.; McCullough & Dalzell Co.; Robinson-Rae Mfg. Co., 329 Water St.; Seaman, Sleeth Co., 41st St. and Willow; S. D. Sleeth, Westinghouse Air Brake Co.; Wm. Yagle & Co., Ltd., 32d St. and A. V. R. R.; The Carnegie Steel Co., Ltd.

Philadelphia—Stanley G. Flagg & Co., 19th & Pennsylvania Ave.; Girard Iron Works, 22d & Master; Wm. Hanson, 5404 Lancaster Ave.; Arthur W. Howe; Dr. Edward Kirk, 535 N. 10th St.: Morris Wheeler & Co., 16th & Market Sts.; J. W. Paxson & Co., Rogers, Brown & Warner, Bullitt Bldg.; Isaac A. Sheppard & Co.; Robt. J. Taylor & Son; Josiah Thompson, J. Thompson & Co.; Wilbraham Baker Blower Co.; Walter Wood, R. D. Wood & Co., 400 Chestnut St.; David J. Matlack, 2247 Richmond St.; Wm. Sellers & Co., Inc., 1600 Hamilton St.; W. W. Stevens, 9th and Montgomery Ave.; Asa W. Whitney, 1601 Callowhill St.

Quakertown—Francis Cavanaugh, Quakertown Stove Works.

Renova—W. H. Nicholas, P. R. R., Foreman of Foundry.

Sharpsville—Thos. D. West, Vice-Pres. & Mgr. Thos D. West Foundry Company.

Tacony—Francis Schumann, Tacony Iron & Metal Co.

Weatherly—Jos. Koons, with L. V. R. R. Co.

Wilkes-Barre—E. H. Jones, 143 S. Franklin St.

RHODE ISLAND.

Providence—Alonzo D. Amsden, Phoenix Foundry; A. Carpenter & Sons, 272 W. Exchange; Theo. H. Colvin, Theo. H. Colvin Foundry Co.; Alfred J. Miller, Vice-Pres. Whitehead Bros.' Co.

TENNESSEE.

Chattanooga—Henry Clay Evans, Mgr. Chattanooga Car & Foundry Co.

TEXAS.

Dallas—Mosher Mfg. Co.

VERMONT.

Montpelier—Lane Mfg. Co.

WASHINGTON.

Seattle—Geo. James, Mgr. Variety Iron Works.

Tacoma—Olympic Iron Works.

WISCONSIN.

Milwaukee—Northwestern Malleable Iron Co.

CANADA.

Londonderry—Chas. L. Jobb, Londonderry Iron Co.

Montreal, P. Q.—Warden, King & Son.